

Project Manual For:

**The Park Danforth
Portland, Maine**

Park Danforth

Construction Documents

**Project 13-059-00
June 5, 2015**

Previously Issued:

(Site Pricing Set March 25, 2015)

(Package 1: Structural Bid Set May 27, 2015)

LAVALLEE | BRENSINGER ARCHITECTS

155 Dow Street, Suite 400, Manchester, NH 03101

40 Cambridge Street, Charlestown, MA 02129

tel 603.622.5450 617.398.2035

web LBPA.com

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**SECTION 00 01 03
PROJECT DIRECTORY**

OWNER

The Park Danforth

777 Stevens Avenue, Portland, Maine 04103

ARCHITECT

Lavallee Brensinger Architects (LBA)

155 Dow Street, Suite 400, Manchester, New Hampshire 03101

40 Cambridge Street, Charlestown, Massachusetts 02129

Telephone NH: 603-622-5450 Telephone MA: 617-398-2035

Contact: Danielle Santos, Associate E-mail: danielle.santos@lbpa.com

CONSULTANTS

INTERIOR DESIGNER

TMD Designs (TMD)

223 Atlantic Avenue, North Hampton, New Hampshire 03862

CIVIL ENGINEER/LANDSCAPE ARCHITECT

Mitchell & Associates Landscape Architects

70 Center Street, Portland, Maine 04101

STRUCTURAL ENGINEER

Becker Structural Engineers, Inc. (BSE)

75 York Street, Portland, Maine 04101

FIRE PROTECTION, PLUMBING, MECHANICAL, ELECTRICAL ENGINEERS

Allied Engineering

160 Veranda Street, Portland, Maine 04103

EQUIPMENT CONSULTANT

Crabtree McGrath Associates, Inc.

161 West Main Street, Georgetown, Massachusetts 01833

CONSTRUCTION MANAGER

PC Construction Company

131 Presumpscot Street, Portland, Maine 04103

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DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building demolition excluding removal of hazardous materials and toxic substances.
 - 1. Provide complete demolition and removal of existing unoccupied buildings and structures noted, including all walls, partitions, roofing, foundations, slabs-on-grade, building finishes and contents.
- B. Selective demolition of built site elements.
- C. Selective demolition of building elements for alterations purposes and as otherwise required for the complete and proper execution of the Work.
- D. Abandonment and removal of existing utilities and utility structures.
- E. The Work of this Section is not necessarily fully represented on the Drawings or specifically identified herein. The Contractor, either himself or through his various subcontractors, shall thoroughly review all available documents and shall visit the site and existing building prior to bidding, as required to fully satisfy himself as to the types, locations and quantities of demolition work required for the complete and proper execution of the Work. No pleas of misunderstanding resulting from the failure to adequately inspect existing conditions will be entertained and no additional expenses related thereto will be granted.

1.02 RELATED REQUIREMENTS

- A. Section 01 50 00 - Temporary Facilities: Site fences, security, protective barriers, and waste removal.
- B. Section 01 71 00 - Cutting and Patching
- C. Section 01 74 19 - Construction Waste Management: Limitations on disposal of removed materials; requirements for recycling.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.04 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of 5 years of documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

- A. For replacement of Work removed, use materials that comply with the pertinent Sections of these Specifications. All other materials, not specifically described but required for a complete and proper job, shall be as selected by the Contractor, subject to the approval of the Architect.

PART 3 EXECUTION

3.01 SPECIAL REQUIREMENTS FOR DEMOLITION

- A. All methods, techniques and procedures of safety, shoring, barricading, fencing, protection, demolition, removal and disposal are left solely to the discretion of, and shall be the responsibility of the Contractor. Special attention shall be paid to the issues of safety and protection of existing construction and/or landscaping and site improvements to remain. The

Contractor shall take all precautions necessary to prevent the movement, settlement, or failure of adjacent construction. See Section 01 00 00 - General Requirements, for additional information.

- B. Per EPA regulations, beginning April 2010, contractors performing renovation, repair, and painting in residential that disturb lead paint (assumed to be any building construction prior to 1978) shall be certified and shall follow specific work practices that include notification of occupants and sealing off the work area. The rule does not apply to minor maintenance or repair activities where less than six square feet of lead-based paint is disturbed in a room or where less than 20 square feet of lead-based paint is disturbed on the exterior.
- C. The Contractor shall be responsible for compliance with all applicable Local, State and Federal environmental regulations, including but not limited to the National Emission Standard for Hazardous Air Pollutants, as enforced by the United States Environmental Protection Agency. It shall be the Contractor's responsibility to provide all inspections and notifications related thereto.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain and pay for all required permits and approvals required for demolition, hauling, dumping and in general, all activities related to the Work of this Section.
 - 2. Comply with applicable requirements of NFPA 241.
- B. The Contractor shall be alert to potential problems or dangerous conditions. He shall exercise caution during demolition or removal which may affect structural safety. He shall proceed only when he has fully satisfied himself that he has provided proper support, shoring, bracing, protection, and safety precautions.
 - 1. If uncovered conditions are not as anticipated, immediately notify the Architect and secure needed directions. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved
 - 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 3. Provide, erect, and maintain temporary barriers and security devices.
 - 4. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 5. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 6. Do not close or obstruct roadways or sidewalks without permit.
 - 7. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
 - 8. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- C. Do not begin removal until receipt of notification to proceed from Owner.
- D. Protect existing structures and other elements that are not to be removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
- E. Minimize production of dust due to demolition operations; Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- F. The Architect's Scope of Services and responsibilities exclude the investigation, discovery, detection, identification, presence, leakage, release, use, handling, disposal, encapsulation, abatement, treatment or removal of, or exposure of a person or persons to, hazardous materials, pollutants, contaminants, or disease transmitting organisms, pre existing or otherwise

deposited at any time and in any form at the Project, including but not limited to volatile organic compounds, molds, fungus, bacteria, petroleum products, lead, asbestos or asbestos products, radon and electro-magnetic frequency radiation or other radiation. Should any such substances be encountered, the Owner and Architect shall be promptly notified, in writing.

- G. Perform demolition in a manner that maximizes salvage and recycling of materials.
 - 1. Comply with requirements of Section 01 74 19 - Waste Management.
 - 2. Dismantle existing construction and separate materials.
 - 3. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
- H. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

- A. The termination, demolition, and removal of utilities shall comply with the procedures, regulations, and recommendations of related utilities and governing authorities. The Contractor shall contact such agencies prior to proceeding, in order to assess their requirements and ensure proper coordination and full compliance.
- B. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- C. Protect existing utilities to remain from damage.
- D. Do not disrupt public utilities without permit from authority having jurisdiction.
- E. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- F. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- G. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- H. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as shown.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from other areas that are still occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 in locations indicated on drawings.
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
- D. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
 - 2. Remove items indicated on drawings.
- E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, Telecommunications, and data systems): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.

2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 3. Verify that abandoned services serve only abandoned facilities before removal.
 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- F. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
 4. Patch as specified for patching new work.

3.05 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Remove from site all materials not to be reused on site; comply with requirements of Section 01 74 19 - Waste Management.
- C. Contractor shall leave the site in neat, clean and safe condition, with all appropriate barricades, fencing, warning signage, etc. securely in place, ready for subsequent work.
- D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 03 54 00
CAST UNDERLAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Liquid-applied self-leveling floor topping with color stain, polished finish and sealer.
- B. Liquid-applied self-leveling floor underlayment.

1.02 REFERENCE STANDARDS

- A. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2012.
- B. ASTM C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars; 2014.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data sheets documenting physical characteristics and product limitations of underlayment materials. Include information on surface preparation, environmental limitations, and installation instructions.
- C. Samples: Submit a range of 8" x 8" min size samples demonstrating variation of surface finish color and polish for selection.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years of experience and approved by the manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep dry and protect from direct sun exposure, freezing, and ambient temperature greater than 105 degrees F.

1.06 MOCK-UP

- A. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
- B. Accepted mock-up(s) may remain as part of the Work. Unsatisfactory mock-ups shall be removed.

1.07 FIELD CONDITIONS

- A. Do not install underlayment until floor penetrations and peripheral work are complete.
- B. Maintain minimum ambient temperatures of 50 degrees F 24 hours before, during and 72 hours after installation of underlayment.
- C. During the curing process, ventilate spaces to remove excess moisture.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cementitious Underlayment: Blended cement mix, that when mixed with water in accordance with manufacturer's directions will produce self-leveling underlayment.
 - 1. Compressive Strength, ASTM C109: Minimum 4000 psi after 28 days.
 - 2. Flexural Strength, ASTM C348: Minimum 1000 psi after 28 days.
 - 3. Density: 125 lb/cu ft, nominal.

4. Final Set Time: 1-1/2 to 2 hours, maximum.
 5. Thickness: Capable of thicknesses from feather edge to maximum 3-1/2 inch.
 6. Surface Burning Characteristics, ASTM E84: Flame spread/Smoke developed index of 0/0.
 7. Products:
 - a. Ardex K15 by Ardex Engineered Cements.
 - b. Koster SL Premium Self-Leveling Underlayment by Koster.
 - c. Laticrete Supercap by Laticrete LLC.
 - d. Substitutions: Substitution submittals shall be a standard format developed by the Contractor and approved by the Architect including the following information
- B. Aggregate: Dry, well graded, washed silica aggregate, approximately 1/8 inch in size and acceptable to underlayment manufacturer.
- C. Water: Potable and not detrimental to underlayment mix materials.
- D. Primer: Manufacturer's recommended type.
- E. Joint and Crack Filler: Latex based filler, as recommended by manufacturer.

2.02 MIXING

- A. Site mix materials in accordance with manufacturer's instructions.
- B. Add aggregate for areas where thickness will exceed 1/2 inch. Mix underlayment and water for at least two minutes before adding aggregate, and continue mixing to assure that aggregate has been thoroughly coated.
- C. Mix to self-leveling consistency without over-watering.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that underlayment is compatible with scheduled floor covering and adhesives.
- B. Verify that substrate surfaces are clean, dry, unfrozen, do not contain petroleum byproducts, or other compounds detrimental to underlayment material bond to substrate. Do not use acid or mastic removers on any surface. Surfaces shall be 50 degrees F, minimum and 90 degrees F maximum.
- C. Owner's testing agency shall test concrete slabs prior to installation of any self-leveling underlayment. Test results shall be made available to the contractor for determination of appropriate product. Contractor shall obtain instructions from manufacturer if test results are not within their recommendation limits. Testing shall include:
 1. Internal relative humidity, per ASTM F2170
 2. MVER per ASTM F-1869.
 3. Alkalinity, pH rates per ASTM 710.

3.02 CEMENTITIOUS UNDERLAYMENT PREPARATION

- A. Concrete: Mechanically prepare steel troweled concrete to create a textured surface necessary to achieve the best bond; acceptable methods include bead blasting and scarifying. Do not use acid etching.
- B. Remove substrate surface irregularities. Fill voids and deck joints with filler. Finish smooth.
- C. Vacuum clean surfaces.
- D. Prime substrate in accordance with manufacturer's instructions. Allow to dry.
- E. Close floor openings.

3.03 TOPPING PREPARATION

- A. Concrete Substrate: Mechanically prepare steel troweled concrete to create a textured surface necessary to achieve the best bond; acceptable methods include bead blasting and scarifying. Do not use acid etching.

- B. Remove substrate surface irregularities. Grind to remove high spots and pre-level with CMP 210 for low areas. Finish smooth.
- C. Vacuum clean surfaces.
- D. Prime substrate in accordance with manufacturer's instructions. Allow to dry.
- E. Close floor openings.
- F. Mix underlayment product with color additive in accordance with manufacturer's instructions. Product shall provide a consistent coloration.
- G. Non-moving Crack Preparation: Thoroughly clean and chase cracks and saw-cuts. Fill with specified product.
- H. Working Cracks: Install expansion - contraction joint assemblies or fill with sealants specified for high movement joints as specified in Section 07 90 05 - Sealants.
- I.

3.04 APPLICATION

- A. Install products in accordance with manufacturer's instructions.
- B. Pump or pour material onto substrate. Do not retemper or add water.
 - 1. Pump, move, and screed while the material is still highly flowable.
 - 2. Be careful not to create cold joints.
 - 3. Wear spiked shoes while working in the wet material to avoid leaving marks.
- C. Place to indicated floor elevation, achieving a minimum 1/8 inch thickness, with top surface level to 1/8 inch in 10 ft.
- D. If a fine, feathered edge is desired, steel trowel the edge after initial set, but before it is completely hard.

3.05 CURING

- A. Once underlayment starts to set, prohibit foot traffic until final set has been reached.
- B. Air cure in accordance with manufacturer's instructions.

3.06 FIELD QUALITY CONTROL

- A. Placed Material: Agency will inspect and test for conformance to specification requirements.

3.07 PROTECTION

- A. Protect against direct sunlight, heat, and wind; prevent rapid drying to avoid shrinkage and cracking.
- B. Do not permit traffic over unprotected floor underlayment surfaces.

END OF SECTION

SECTION 04 20 00
UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete Block, including standard shapes, solid units and grout filled cores as required.
- B. Facing Brick including standard and custom shapes, solid units and grout filled cores as required.
- C. Mortar and Grout.
- D. Reinforcement, Ties, and Anchorage.
- E. Flashings.
- F. Building-in and grouting of all hollow metal frames.
- G. Repair of existing masonry to remain. (NOTE: In general, the repair of existing masonry shall include the replacement of broken materials and the repointing of mortar joints.) See Section 01 21 00 - Allowances.
- H. Building-in of lintels, bearing plates, anchors, and items supplied by other trades.
- I. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 04 72 00 - Cast Stone Veneer.
- B. Section 05 50 00 - Metal Fabrications: Loose steel lintels and embedded items.
- C. Section 07 21 00 - Thermal Insulation: Insulation for cavity spaces.
- D. Section 07 25 00 - Weather Barriers - Weather barrier and membrane flashings in cavity.
- E. Section 07 62 00 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.
- F. Section 07 84 00 - Firestopping: Firestopping at penetrations of masonry work.
- G. Section 07 90 05 - Joint Sealers: Backing rod and sealant at control and expansion joints; compressible fillers at relieving angles.

1.03 REFERENCE STANDARDS

- A. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures and Related Commentaries; American Concrete Institute International; 2011.
- B. ACI SP-66 - Detailing Manual for Reinforced Concrete, Latest Edition.
- C. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2007.
- D. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2012.
- E. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile; 2013.
- F. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units; 2014.
- G. ASTM C91 - Standard Specification for Masonry Cement; 2012.
- H. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units; 2011.
- I. ASTM C140/C140M - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units; 2014.
- J. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2011.
- K. ASTM C150 - Standard Specification for Portland Cement; 2012.
- L. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2006 (Reapproved 2011).

- M. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale); 2014.
- N. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2012.
- O. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2011.
- P. ASTM C476 - Standard Specification for Grout for Masonry; 2010.
- Q. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2012.
- R. ASTM C1142 - Ready-mixed Mortar for Unit Masonry.
- S. ASTM E447 - Masonry Prism Test
- T. ASTM E514 - Water Penetration and Leakage Through Masonry.
- U. NCMA - Specification for the Design and Construction of Load Bearing Concrete Masonry.
- V. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete; 2010.
- W. ASTM C1148 - Standard Test Method for Measuring the Drying Shrinkage of Masonry Mortar; 1992a (Reapproved 2008).
- X. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms; 2012.
- Y. ASTM C1357 - Standard Test Methods for Evaluating Masonry Bond Strength; 2009.
- Z. CRSI Manual of Standard Practice, Latest Edition.
- AA. CRSI Placing Reinforcing Bars, Latest Edition.
- AB. UL - Fire Resistance Directory; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Convene a pre-installation meeting at least 1 month before starting work of this Section; require attendance by all relevant installers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, certified mill reports for deformed bar reinforcement, mortar, grout, masonry accessories, and all other manufactured products.
- C. Shop Drawings:
 - 1. Submit shop drawings of all masonry reinforcement detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315 - Details and Detailing of Concrete Reinforcing, showing bar schedules, stirrup spacing, lap lengths, diagrams of bent bars, and arrangement of masonry reinforcement, including elevations of all reinforced walls. Wall elevations shall include reinforcing at all architectural and mechanical openings.
 - 2. Submit control and expansion joint locations to architect prior to masonry installation.
- D. Samples:
 - 1. Submit five samples of facing brick units to illustrate color, texture, and extremes of color range.
 - 2. Submit samples of each type of reinforcement, ties, anchors, flashing, expansion joints, joint fillers, weeps, etc.
- E. Manufacturer's Certificates: Submit prior to delivery of materials to the job site. Certify that masonry units and mortar and grout meet or exceed specified requirements.
- F. Test Reports: Submit in dependent testing lab certificates:
 - 1. Mortar mix designs and test results including proportions and mortar ingredients.
 - 2. Grout mix designs and test results including description of type and proportions of grout ingredients.

3. Masonry units compression, absorption and measurement test result

1.06 QUALITY ASSURANCE

- A. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.
- B. For all concrete masonry units requiring a fire resistance rating, provide one of the following:
 1. Certification from Underwriter's Laboratories (UL) for products used in the tested assemblies as indicated on the Drawings.
 2. Certification from a Maine state accredited testing agency certifying fire-resistance rating compliance in accordance with UL618 and ACI 216.1/TMS216.1 "Standard Method of Determining Fire Endurance of Concrete and Masonry Construction Assemblies" for an equivalent product to that used in the tested assemblies as indicated on the Drawings.
 3. For assemblies 1-hour fire-rated or less, provide documentation of calculated fire resistance per IBC Section 720 in accordance with ACI 216.1/TMS 216.1.
- C. Pre-construction Testing: If manufacturer's published test reports are not available, the Contractor shall employ and pay an approved testing laboratory to perform pre-construction testing for:
 1. Concrete unit masonry tests for each different unit for strength, absorption, and moisture content per ASTM C140 and fire-resistive tests per UL 618 and ACI 216.1/TMS 216.1.
 2. Clay Unit Masonry Tests for each different unit per ASTM C67.
 3. Prism tests for each type of wall construction per ASTM E447.
 4. Mortar testing per ASTM C780.
 5. Grout compressive strength testing per ASTM C1019.

1.07 MOCK-UPS AND SAMPLE PANELS

- A. Mock-Up Panel(s): Construct masonry wall mock-up panel(s) sized 8 feet long by 6 feet high with an outside corner at least 2 feet long; including all components typical to the exterior wall construction, including but not limited to masonry units, mortar and accessories and flashings metal studs, sheathing, weather barrier, sealant, sample window, and insulation.
 1. Mock-up panel shall be constructed in a timely manner to allow for review and modifications if necessary prior to start of any related construction
 2. Contractor shall provide a concrete pad and all necessary support framing to hold mock-up panel in vertical position. Locate mock-up panel where directed by Architect
 3. Mock-up panel(s) shall be of proper thickness, showing proposed masonry color range, texture, bond, mortar joint and workmanship proper installation of various wall components, relationship of mortar and sealant colors to stone colors; tooling of joints; and aesthetic qualities of workmanship. No work shall progress until the Architect has reviewed the mock-up panel(s). Panel(s) shall be revised as necessary to secure the Architect's acceptance.
 4. Mock-up panel(s) shall then become the standard of comparison for all masonry work built of the same material. The panel(s) shall not be destroyed or moved until the Work is complete and accepted by the Architect.
 5. Contractor shall remove mock-up panel(s) after exterior punch-list is completed.
- B. Sample Panel - Existing Masonry Repair: Prior to existing masonry repair materials approval, prepare up to two samples, 4 square feet in size of masonry panels with each type of mortar under consideration. The sample panels shall be of the proper joint width, color, texture, and workmanship. No work shall progress until the Architect has reviewed the sample panels. Samples shall be revised as necessary to secure the Architect's acceptance. Accepted samples may remain as part of the Work and shall become the standard of comparison for all masonry work built of the same material. Rejected samples shall be carefully removed to minimize damage to masonry.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
 - 1. The maximum moisture content of concrete block when laid shall not exceed 30% for exterior exposures and 25% for interior exposures (as a percent of total absorption and is in addition to moisture level required under ASTM C90).
- B. All mortar materials shall be stored under cover in a dry place.
- C. Reinforcement steel, ties, and anchors shall be protected from the elements and, before being placed, shall be free from loose rust and other coating, including ice, that will destroy or reduce the bond.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete Masonry Units: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depths as indicated on the drawings for specific locations.
 - 2. Special Shapes: Provide non-standard blocks configured for corners and other detailed conditions.
- B. Load-Bearing Concrete Masonry Units - CMU: ASTM C90, normal weight.
 - 1. Both hollow and solid block, as indicated. Type 1, 1900 psi minimum compressive strength.
 - 2. Solid Units: Provide identical solid block units as follows:
 - a. At corbelled units and courses below corbelled units.
 - b. Where indicated on the Drawings.
 - 3. Interior Units: Smooth uncolored faces, unless otherwise indicated.
- C. Non-Loadbearing Units: ASTM C129. Type 1.
 - 1. Both hollow and solid block, as indicated.
 - 2. Normal weight.
 - 3. Minimum compressive strength based on net solid area shall be 1500 psi.

2.02 BRICK UNITS

- A. Manufacturers:
 - 1. Basis of Design:
 - a. Brick Type 1: Utility Brick # 8520 by Belden Brick.
 - b. Brick Type 2: Utility Brick # 671 Velour by Belden Brick.
 - c. Brick Type 3: To Be Field Matched.
 - 1) The intent of Brick Type 3 is to match existing masonry units in locations noted for infill or repair per the Drawings. Manufacturer to field match and submit for approval by the Architect required masonry units.
 - d. Acceptable manufacturer's:
 - 1) Boral Bricks, Inc
 - 2) Glen Gery.
 - 2. Substitutions: See section 01 60 00 - Product Requirements.
- B. Facing Brick: ASTM C 216, Type FBX, Grade SW.
 - 1. Color and texture to match Architect's sample.
 - 2. Nominal size: As indicated on drawings.
 - 3. Solid Units: Provide matching solid units with all faces finished at all brick on top courses below horizontal expansion joints, sills, caps, and locations as required.
 - 4. Special shapes: Molded units as required by conditions indicated. All brick to be used to form outside corners shall be factory formed to provide return legs, as required to maintain a full running bond without clipped brick or mitered corners.

5. Efflorescence, ASTM C67: Not Effloresced.
6. Initial Rate of Absorption, ASTM C67: Less than 20g per 30 sq. in/minute.

2.03 BRICK MORTAR AND GROUT MATERIALS

- A. Pre-mixed Masonry Cement: ASTM C 270; ASTM C 91, Type S, commercially prepared type of Portland Cement Type 1 and hydrated lime Type S.
 1. Products:
 - a. Quik-crete, Type S Portland/Lime Blend.
 - b. Blue Circle.
 - c. Eagle Bond.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979.
 1. Color(s): As selected by Architect from manufacturer's full range.
 - a. Basis of Design: Premium Group by Davis Colors.
 2. Manufacturers:
 - a. Davis Colors
 - b. Lambert Corporation
 - c. Solomon Colors
 3. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Water: Clean and potable.
- D. Admixtures: Admixtures shall not be used without the Architect's written permission, unless specified herein.

2.04 REINFORCEMENT AND ANCHORAGE

- A. Manufacturers of Joint Reinforcement and Anchors:
 1. Blok-Lok Limited.
 2. Hohmann & Barnard, Inc.
 3. Wire-Bond.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Reinforcing Steel: ASTM A 615 Grade 60 (420) deformed billet bars; uncoated, and shall be in conformance with Section 03 30 00.
- C. Single Wythe Joint Reinforcement: Ladder type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B2 and for interior walls to ASTM A641, Class 1. Standard 0.1483 inch (9 gauge) side rods with 0.1483 inch (9 gauge) cross rods. Width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.
 1. Products:
 - a. Lox-All Ladder-Mesh 220 by Hohmann & Barnard / Dur-O-Wall.
 - b. BL-10 by Blok-Lok.
 - c. Ladder 2 Wire by Wire-Bond.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Masonry Sill Anchors: (For sloped brick sills) One-piece, 3/16 inch minimum thickness, galvanized wire, bent to "Z" configuration of appropriate size. Anchors shall secure sills to veneer brick below.
- E. Masonry Veneer Anchors: (For Masonry -Metal Stud Cavity Walls) 2-piece adjustable veneer anchor and pintel tie, hot dip galvanized to ASTM A 153/A 153M, Class B2.
 1. Anchor Plates: Not less than 0.075 inch (14 gauge) thick, by 1-1/4 inch wide, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
 2. Adjustable Pintel Wire ties: Triangular shape, 3/16 inch thick minimum. Tie length shall be as required for a minimum 2" tie embedment in mortar.

3. Insulation Thickness: 3 inches unless otherwise indicated.
4. Air Cavity Thickness: 2 inches unless otherwise indicated.
5. Adjustable Pintle Wire Ties: Triangle shape, 3/16 inch thickness. Tie length shall be as required for a minimum 2" tie embedment in mortar.
6. Pintle Seismic Feature: Provide lip, hook, or clip on extended leg of wall ties to engage or enclose not less than one continuous horizontal joint reinforcement wire of 0.1483 inch diameter.
7. Products (Basis of Design):
 - a. Pos-i-Tie Thermal Clip with adjustable Double Pintle Wire Tie by Heckman Building Products.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Single Strand Reinforcement (For brick sills, soldier course and stack bond): Continuous single strand, galvanized, No. 9 gauge deformed wire.
- G. Fasteners: Anchors shall be mechanically fastened to metal studs using self-drilling, self-tapping screws of sizes and types as recommended by the tie manufacturer. Screw finish shall be Type 304 stainless steel or a high performance polymer coating, complying with ASTM B117, salt spray test result of no rust or other base metal corrosion after a minimum of 800 hours.
 1. Coating Products:
 - a. Kwik-Cote by Hilti.
 - b. Stahlgard by Elco.
 - c. ITW-Buildex.
 - d. SX by SFS Stadler.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Prefabricated Joint Reinforcing: Provide continuous welded wire units prefabricated in straight lengths of not less than 10', with matching corner and tee units. Fabricate from cold-drawn steel wire complying with ASTM A-82, deformed continuous side rods with 3/16" diameter and plain 9 gage cross rods, unit width of 1-1/2" less than thickness of wall/partition. Subject to compliance, provide products manufactured by "Dur-O-Wal", "AA Wire Products Company", or approved equal.
 1. Single Width Walls: Truss type fabricated with single pair 3/16 gauge side rods and 9 gage continuous diagonal cross rods.
- I. Reinforcing Bar Positioners: Provide reinforcing bar supports/positioners for accurate positioning of horizontal and vertical reinforcement in walls, bond beams, and lintels. Fabricate from cold-drawn plain 9 gage steel wire complying with ASTM A-82. Subject to compliance, provide products manufactured by "Dur-O-Wal", "AA Wire Products Company", or approved equal.

2.05 FLASHINGS

- A. Drip Edge Flashing (for termination of membrane flashings at exterior face of masonry and across cavities): 0.040 inch Type 304 stainless steel continuous drip flashing, shape as indicated on the Drawings. Drip edge flashing shall extend into cavity to support membrane thru-flashing.
 1. Membrane thru-flashing provided by Section 07 25 00 - Weather Barriers shall be adhered to the top surface of drip flashing.
- B. Cavity Wall Flashing Materials: See Section 07 25 00 - Weather Barriers.

2.06 ACCESSORIES

- A. Wall Drainage Baffle: Polyester mesh panels designed for installation at flashing locations to prevent mortar droppings from clogging weeps. Size with of baffle to match depth of cavity.
 1. Products:
 - a. Advanced Building Products Inc; Mortar Break DT.
 - b. Mortar Net USA, Ltd; Product MortarNet.

- c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Weep Holes and Cavity Vents: Polypropylene honeycomb, full joint height, color as selected by the Architect.
 - 1. Products:
 - a. Dur-O-Wal; Product DA 1006 Cell Vent.
 - b. Hohmann & Barnard, Inc; Product Quadrovent.
 - c. Mortar Net USA, Ltd; Product Weep Vents.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.
 - 1. Manufacturers:
 - a. ProSoCo Inc, Sure-Klean, VanaTrol
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 CMU MORTAR AND GROUT MIXES

- A. Mortar for Unit Masonry: Pre-mixed masonry cement; ASTM C270; ASTM C91, commercially prepared type of Portland Cement Type 1 and hydrated lime Type S.
 - 1. Masonry below grade and in contact with earth: Type S., 1800 psi min.
 - 2. Interior, loadbearing masonry: Type S.
 - 3. Interior, non-loadbearing masonry: Type S.
- B. Mortar for UL Design CMU: Comply with UL design requirements, not less than 2-1/4 and not more than 3-1/2 parts of clean sharp sand to 1 part Portland cement (proportioned by volume) and not more than 50 percent hydrated lime (by cement volume).
- C. Grout: ASTM C476, type Fine. Minimum 28-day compressive strength shall be 3,000 psi. Maximum aggregate size: 3/8". Consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches. See Structural Drawings for further information.
- D. Use of accelerating admixtures in cold weather and set-retarding admixtures during hot weather only when reviewed and approved by the Architect.
- E. Do not add admixtures including coloring pigments, air-entraining agents, water-repellant agents, antifreeze compounds or other admixtures unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION – GENERAL

- A. General: Build masonry construction as required in related specification sections and as identified on the drawings. Build masonry construction to full thickness shown, except, single-wythe walls to actual thickness of masonry units, using units of nominal thickness shown or specified.
- B. Do not use frozen materials or materials mixed/coated with ice or frost. Do not build on frozen work. Remove and replace masonry work damaged by frost or freezing. Do not wet concrete masonry units (CMU).
- C. Mortar: Provide full mortar coverage on all horizontal and vertical surfaces including face shells and webs.
- D. Reinforced Concrete Masonry Unit Walls: Lay CMU wall units in running bond with vertical joints in each course centered on units above and below, unless otherwise indicated. Bond and interlock each course at corners and intersections. Use special shaped units where shown, and/or as required for corners, jambs, sash, control joints, lintels, bond beams, and other special conditions.

1. Maintain vertical continuity of core or cell cavities which are to be reinforced and grouted. Keep cavities free of mortar. Solidly bed webs of masonry with mortar where adjacent to cells to be grouted.
2. Use special units or modify standard units, where horizontal reinforcing is shown to provide for continuous placement of reinforcing and grout. Place small mesh expanded metal lath or wire screening in joints under bond beam courses above cells of non-reinforced or non-grouted masonry elements or provide bond beam units with solid bottoms (lintel block units). Provide open end bond beam units where horizontal and vertical reinforcing pass through same units.

3.02 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other Sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.03 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
- C. Steel sleeves shall be installed for all piping and cabling through masonry construction. Coordinate with Fire Protection, Plumbing, Mechanical and Electrical Divisions.

3.04 PROTECTION OF WORK

- A. During erection, all walls shall be kept dry by covering at the end of each day or shutdown period with a strong, waterproof membrane. Partially completed walls not being worked on shall be similarly protected at all times. Covering shall completely cover all projecting rebar and overhang walls at least 2' on each side, and shall be securely held in place.

3.05 COLD AND HOT WEATHER REQUIREMENTS

- A. Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.
- B. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.
- C. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

3.06 COURSING, JOINTING AND BOND PATTERN

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. All masonry work shall be properly coordinated as required to maintain aligned coursing throughout the building, unless specifically noted otherwise.
- D. Standard Concrete Masonry Units:
 1. Bond: Running.
 2. Coursing: One unit and one mortar joint to equal 8 inches.
 3. Mortar Joints: Concave.
 4. Joints scheduled to receive resilient floor base and other joints not exposed to view shall be flush-cut.
 5. Joints within exterior masonry cavity walls to receive sprayed-on vapor retarder membrane shall be flush tooled with the CMU surface and all CMU surface voids filled smooth.
- E. Brick Units:
 1. Bond: Running.

2. Coursing: Three units and three mortar joints to equal 8 inches.
 3. Mortar Joints: Concave.
- F. Sealant Recesses: Outside joints around the perimeter of exterior door and window frames or other wall openings shall be not less than 1/4" nor more than 3/8" wide, and shall be cleaned out to a uniform depth of at least 3/4" ready for placement of sealant by other trades.

3.07 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.
- E. Interlock intersections and external corners.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.08 WEEPS/CAVITY VENTS

- A. Install weeps in veneer and cavity walls at 16 inches on center horizontally above through-wall flashing, above shelf angles and lintels, and at bottom of walls.

3.09 CAVITY MORTAR CONTROL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
- B. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.10 REINFORCEMENT AND ANCHORAGE - GENERAL

- A. Wall reinforcement shall be installed continuously in all masonry cavity walls, in all interior block walls and partitions and at all other locations identified on the Drawings or specified herein.
- B. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.
- C. Place concrete masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 24 inches each side of opening.
- D. Unless shown on the Drawings to be more closely spaced or where specifically indicated to be added, horizontal joint reinforcement for concrete masonry shall be installed in the first and second bed joints, 8" apart immediately above lintels and below sills at openings, and in bed joints at 16" vertical intervals elsewhere. Reinforcement in the second bed joint above or below openings shall extend two (2) feet beyond the jambs. All other reinforcement shall be continuous.
- E. Side rods shall be lapped a minimum of 6 inches at splices.
- F. Reinforcement shall be so placed as to assure a 1/2" minimum mortar cover on the faces of walls.
- G. Prefabricated or job fabricated corners and tee sections shall be used to form continuous reinforcement around corners and for anchoring abutting walls and partitions. Materials in corner and tee sections shall correspond to type and design of reinforcement used.
- H. Place horizontal and vertical reinforcing steel in walls and around openings as indicated on the Drawings. See Structural Drawings and Section 03 30 00 - Concrete, for additional information.
- I. Fasten anchors to structural framing abutting masonry and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 16 inches horizontally and 16 inches vertically.

- J. Structural steel clips shall laterally secure the tops of non-loading bearing masonry walls to building structure as indicated on the Structural Drawings.

3.11 REINFORCEMENT AND ANCHORAGE - SINGLE WYTHE MASONRY

- A. Install horizontal joint reinforcement 8 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.

3.12 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.
- E. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.
 - 1. Veneer anchors on the cavity side of the stud wall shall be set in a sealant bed. All penetrations through sheathing shall be sealed.
- F. Seismic Reinforcement: Connect veneer anchors with continuous horizontal wire reinforcement before embedding anchors in mortar.

3.13 PLACING REINFORCEMENT:

- A. General: Clean reinforcement of loose rust, mill scale, earth, ice, or other materials which will reduce bond to mortar or grout. Do not use reinforcement with kinks or bends not shown on drawings or final shop drawings, or bars with reduced cross-section due to excessive rusting or other causes. Position reinforcement accurately at spacing shown on contract drawings.
- B. Vertical Reinforcing: Support and secure vertical reinforcing against displacement. Vertical reinforcing shall be held in position at the top and bottom and at intervals not exceeding 192 bar diameters nor 10'-0" with a minimum clearance of ¼" from the face of the masonry and not less than one bar diameter or 1", whichever is greater, between adjacent bars.
 - 1. For columns, piers, and pilasters, provide a clear distance between vertical bars as indicated, but not less than 1-1/2 times the nominal bar diameter or 1-1/2", whichever is greater. Provide lateral ties as indicated in the details.
 - 2. All dowels shall be grouted even if the dowel is in a cell adjacent to the vertical reinforcing. Unless detailed otherwise on the drawings, dowels shall be the same size, number, and spacing as the vertical reinforcing. Provide lap length of dowels to vertical reinforcing equal to forty-eight (48) times nominal diameter of dowel, unless indicated otherwise on the drawings. Dowels for columns and pilasters shall be installed using steel or wood templates to accurately position dowels as indicated on the drawings.
- C. Horizontal Reinforcing: Support and secure horizontal reinforcing against displacement. Horizontal reinforcing shall be held in position at intervals not exceeding 100 bar diameters with a minimum clearance of ¼" from the face of the masonry and not less than one bar diameter or 1", whichever is greater, between adjacent bars. Provide laps or dowels around corners and across intersections as indicated on the drawings.
 - 1. Horizontal reinforcing shall be placed in continuous bond beam or lintel block units and shall be solidly grouted in place. Horizontal reinforcement shall be CONTINUOUS THROUGH CONTROL JOINTS, but shall be DISCONTINUOUS AT EXPANSION JOINTS. Horizontal reinforcement may be placed as masonry work progresses.

- D. Splices: Splice reinforcement where shown or indicated on the drawings. Do not splice at other locations unless acceptable to the Structural Engineer. Minimum lap splice length shall be 48 bar diameters, of the smaller bar diameter, unless indicated otherwise on the drawings. Stagger adjacent splices at least one full lap length so that no more than 25% of the number of bars are spliced at any one location. Where splicing at vertical bars or at dowels, provide full contact, lap ends of bars, and wire tie.
- E. Reinforcing Bar Positioners: Provide where required and at required spacing to support and secure horizontal and vertical reinforcing against displacement and to accurately align and position splices in reinforcement.
- F. Prefabricated Joint Reinforcing: Provide continuous horizontal joint reinforcing as shown/specified. Fully embed longitudinal side rods in mortar for entire length with minimum cover of 5/8" on exterior side of walls and 1/2" at other locations. Lap reinforcement a minimum of 6" at ends of units. Do not bridge control/expansion joints with joint reinforcing. Provide continuity at corners/wall intersections by the use of prefabricated "L" and "T" sections. Cut/bend units as directed by manufacturer for continuity at returns/offsets/column fireproofing, pipe enclosures, and/or special conditions. Space continuous horizontal reinforcing as follows:
 - 1. For single-wythe walls, space 16" o.c. vertically, unless indicated.
- G. Metal Ties: Where indicate, install in mortar joints as work progresses, with a minimum mortar cover of at least 5/8" on exterior faces and 1/2" on interior faces of masonry work.
- H. Anchors: Install anchors for reinforced masonry elements to supporting structure as indicated on the drawings or required in the specifications.

3.14 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions. Drip flashings shall extend from 1/8 inch beyond exterior face of masonry, across the cavity and turn up face of cavity wall surface at least 4 inches. Membrane flashing shall seal to weather barrier and lap over drip flashing and extend down to 1 inch into brick veneer on top of the drip flashing.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Drip flashing shall be laid in a slurry of fresh mortar and mortar shall be placed on top of the flashing as well to maintain wall flexural strength.
- C. Extend metal flashings through exterior face of masonry and turn down to form drip. Install joint sealer below drip edge to prevent moisture migration under flashing.
- D. Lap end joints of flashings at least 4 inches and seal watertight.

3.15 LINTELS

- A. In general and except where indicated otherwise, masonry lintels shall be provided at all openings in CMU walls 6 inches (nominal) or more in thickness. See Structural Drawings for a schedule of masonry lintels (interior and exterior).
- B. Loose steel angle lintels shall be provided for all openings in brick veneer or 4" CMU masonry as indicated in the lintel schedule or on the Structural Drawings. For miscellaneous loose steel lintels not specified on the structural drawings, refer to Section 05 50 00 - Metal Fabrications.
- C. Vertical cores below lintel ends shall be grouted solid full height to provide suitable bearing. Provide additional reinforcement and filled cores as indicated on the Drawings.
- D. See Architectural and Structural Drawings for additional information related to reinforced concrete masonry lintels.
- E. Temporarily brace lintels as required until mortar has adequately cured.
- F. Install loose steel lintels over openings. All lintels at exterior openings shall be hot-dipped galvanized.

1. Use special shape lip stretcher bricks at steel lintels, as indicated per the Drawings.
- G. Maintain minimum 8 inch bearing on each side of opening, unless otherwise indicated.
- H. A minimum of two courses below lintel ends shall be filled solid with mortar to provide suitable bearing.

3.16 FORMWORK AND SHORING:

- A. General: Provide temporary formwork and/or shoring as required for temporary support of reinforced masonry work. Refer to Division 3, Section 03300 for additional requirements.
- B. Removal: Formwork and/or shoring shall not be removed until the reinforced masonry element has cured sufficiently to carry its own weight and any other loads that may be placed on it during construction. It is the contractor's sole responsibility to determine formwork and shoring requirements and durations. In no case shall formwork or shores be removed before the following periods:
 1. Lintels and beams: 10 days
 2. Masonry soffits: 7 days
 3. Columns and pilasters: 7 days

3.17 GROUTED COMPONENTS

- A. General: Grout mix and grout materials shall conform to ASTM C 476. Refer to Division 3, Section 033000, "Cast-In-Place Concrete" for requirements.
 1. Use "Fine Grout" for filling spaces less than 2" in either horizontal dimension. Where shown solid, use mortar for cavities less than $\frac{3}{4}$ " in width or spaces less than 1-1/2" x 2" in horizontal dimensions.
 2. Use "Coarse Grout" for filling cavities 2" or larger in width or cells 2"x3" or larger in horizontal dimensions.
 3. Use "Concrete", 3000 psi normal weight, for filling spaces ten (10) inches or larger in both horizontal dimensions.
- B. Preparation: Prior to grouting, inspect and clean grout spaces. Remove dust, dirt, mortar droppings, loose pieces of masonry, and other foreign materials. Clean and position reinforcing. Clean top surface of structural members to ensure bond. After final cleaning and inspection, close and brace clean out holes.
 1. Do not grout until entire height of masonry to be grouted has attained sufficient strength to resist forces and pressures of grouting operation. Install shores and braces, if required, before beginning grouting.
- C. Grouting Method: Grouting shall conform to low-lift or high-lift grouting, at Contractor's option, subject to following requirements.
 1. Low-Lift Grouting:
 - a. Low-Lift Grouting SHALL NOT exceed a pour of more than five (5) feet in height not the "Maximum Grout Pour Height" identified below.
 - b. Provide minimum clear dimension of two (2) inches and minimum clear area of eight (8) sq. inches in vertical cavities, cells, or cores to be grouted.
 - c. Place vertical reinforcement prior to laying of masonry units. Extend above elevation of maximum pour height as required to allow for splicing. Support and secure reinforcing as masonry is built.
 - d. Lay masonry to maximum pour height. Do not exceed five feet (5 ft.) or if bond beam occurs below five feet (5 ft.) height, stop pour or course below bond beam.
 2. High-Lift Grouting:
 - a. High-Lift Grouting SHALL NOT exceed a pour of one story, but in no case more than twenty-four (24) feet in height nor the "Maximum Grout Pour Height" identified below.
 - b. High-Lift Grouting is NOT PERMITTED unless minimum cavity dimension exceeds three (3) inches and minimum cavity area exceeds ten (10) sq. inches.

- c. Cleanout holes ARE REQUIRED where high-lift grouting will be employed. Provide cleanouts at the bottom course of masonry at each cell to be grouted for each pour. For solid grouted masonry space cleanouts at 32 in. o.c.
 - d. Cleanout holes shall have minimum width of 3 inches and a minimum height of 6 inches. After cleaning, close cleanouts and brace closures to resist hydrostatic grout pressure.
 - e. Prior to grouting, construct masonry elements and place and secure reinforcing to full height of maximum grout pour. Place horizontal bond beam reinforcing as masonry units are laid.
 - f. Where lateral tie reinforcing is shown, embed in mortar joints at vertical spacing indicated as units are laid. Where lateral ties wrap vertical reinforcing, embed additional lateral tie reinforcing in mortar joints to resist hydrostatic rupture of masonry face shells. Provide not less than No. 2 bars or 8 gage wire ties spaced at 16 in. o.c. for members with side dimensions of 20 in. or less and at 8 in. o.c. where side dimensions exceed 20 in.
- D. Maximum Grout Pour Height: In no case shall total grout pour height exceed the following heights regardless of grouting method used.

Grout Type	Max. Height	Min. Cavity	Min. Cell
Fine	1'-0"	¾"	1-1/2" x 3"
Fine	5'-0"	2"	2" x 3"
Fine	12'-0"	2-1/2"	2-1/2" x 3"
Fine	24'-0"	3"	3" x 3"
Coarse	1'-0"	2"	2" x 3"
Coarse	5'-0"	2"	2-1/2" x 3"
Coarse	12'-0"	2-1/2"	3" x 3"
Coarse	24'-0"	3"	3" x 4"

Min. Cavity applies to grouting between wythes of cavity walls. Min. Cell applies to grouting of masonry cells where dimension shown equals grout space width minus horizontal reinforcing bar diameter.

- E. Grout Placement: Limit grout pours to sections which can be completed in one working day with not more than one (1) hour of interruption of pouring operation. Allow not less than thirty (30) minutes, nor more than one (1) hour between lifts of given pour. Rod or vibrate each lift during pouring operation.
 - 1. Place grout in lifts not to exceed a maximum height of five (5) feet each, regardless of the maximum height of the pour.
 - 2. Place grout in lintels and beams over openings in one continuous pour.
 - 3. Pour grout using chute or container with spout. Terminate pour 1-1/2" below top course to form key for next pour.
 - 4. Where bond beams occur, terminate grouting of vertical cells 1-1/2" below bond beam course. After placing horizontal reinforcing and prior to filling vertical cells above bond beam, pour grout into bond beam and strike off flush with top of bond beam course.
- F. Lintels: Install loose lintels of steel and other materials where shown. Provide masonry lintels where shown and wherever openings of more than 1'-0" are shown without structural steel or other supporting lintels. Provide formed-in-place masonry lintels. Provide minimum bearing at each jamb, of 4" at openings less than 4'-0" wide and 8" for wider openings.
- G. Other Items: Provide vertical expansion, control and isolation joints, and provide concealed flashing and weep holes in masonry where shown. Build-in related masonry accessory items as the masonry work progresses.

- H. Construction Tolerances: Variations in reinforced masonry work from plumb and level, locations of built-in or embedded items, and other required tolerances shall be as required in related specification sections or as identified on the drawings.
- I. Protection of Work: Do not apply uniform loading for at least 12 hours after building masonry walls or columns. Do not apply concentrated loads for at least 3 days after building masonry walls, lintels, beams, columns, pilasters, and piers.
- J. Responsibility for Errors: Contractor shall bear all costs associated with corrective work resulting from errors or poor workmanship, including costs of architectural and engineering services associated with required correction.

3.18 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control or expansion joints.
- B. Size control joint in accordance with Drawing details, but not less than 3/8" for installation of sealant and backer rod specified in Section 07 90 05. Keep joint free and clear of mortar.
- C. Build in horizontal, pressure relieving joints where indicated on the Drawings. Construct joints by inserting a compressible filler of width required and installing sealant and backer rod specified in Section 07 90 05 - Joint Fillers. Locate horizontal, pressure relieving joints beneath relieving (shelf) angles supporting masonry veneer and attached to structure behind masonry veneer.
- D. CMU Control Joints: For interior and exterior concrete masonry partitions in general as follows:
 - 1. At locations not to exceed 25' o.c., or 150% of the height of the CMU wall, or as otherwise indicated on the Drawings, whichever is less.
 - 2. Adjacent to corners and intersections of walls within a distance equal to half the general control joint spacing noted above.
 - 3. At changes in wall height or thickness.
 - 4. Above movement joints in foundations and floors.
 - 5. Below movement joints in foundations and floors.
 - 6. At one side of openings less than 6' wide and at both sides of openings more than 6' wide, located beyond opening reinforcing where applicable.
- E. Brick Veneer Control Joints: For exterior brick veneer masonry in general as follows:
 - 1. At locations not to exceed 23 feet o.c., or as otherwise indicated on the Drawings, whichever is less.
 - 2. Adjacent to corners of walls, with the sum of the distance to the corner at each wall totaling the typical joint spacing and no greater than 10' from the corner.
 - 3. At changes in wall height.
 - 4. At wall offsets.
 - 5. Below relieving angles.
 - 6. Adjacent to openings as indicated on the Drawings.

3.19 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.20 TOLERANCES

- A. Maximum Variation from Alignment of Columns: 1/4 inch.
- B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft, 3/8 inch in any story and 1/2 inch in 40 feet or more.
- D. Maximum Variation from Plumb at openings (windows, doors, etc): 1/8 inch in total height of opening.
- E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in 40 feet or more.
- F. Maximum Variation from Level Coursing: 1/4 inch in any bay or 20 feet; 1/2 inch in 40 feet or more.
- G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.
- H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.21 NON-FIRE RATED AND ACOUSTICAL CONSTRUCTION

- A. General: The following requirements shall apply to all non-fire rated masonry partitions and to all non-fire rated masonry partitions indicated on the Drawings to be "Acoustical Construction".
- B. Where the tops of non-load bearing partitions meet the underside of the structure above, and where gaps in partitions are provided to allow for the penetration of structural members, safing insulation shall be installed. Insulation shall be compression fit and shall not be visible from below.
- C. Acoustic Sealing and Smoke Sealing: Seal all cracks, joints, and voids in "Acoustical Construction" and in non-fire rated smoke partitions, air tight with sealing products specified in Section 07 9005. Assemblies identified as "Acoustic Construction" are not fire-rated construction. Firestop products are required at fire-rated construction. Acoustic sealing and smoke sealing operations shall include, but shall not necessarily be limited to:
- D. Sealing top of masonry partitions for Acoustical Construction on two sides at interface of top of wall to deck flutes.
- E. Sealing all penetrations for pipes, conduits, structure, etc.

3.22 FIRE RATED CONSTRUCTION

- A. General: The following requirements shall apply to all fire rated masonry partitions indicated on the Drawings.
- B. Where the tops of non-load bearing partitions meet the underside of the structure above, and where gaps in partitions are provided to allow for the penetration of structural members, safing insulation shall be installed. Insulation shall be compression fit and shall not be visible from below.
- C. Firestopping: Seal all cracks, joints, and voids in fire rated masonry partitions with firestop products specified in Section 07 84 00. Coordinate with the Work of Section 07 90 05.
- D. Masonry products and installations shall conform to the requirements of the specified U.L. listed assemblies.

3.23 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, sleeves, and ductwork. Coordinate with other Sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.24 FIELD QUALITY CONTROL

- A. Testing Agency/Project Special Inspector shall verify reinforcement, including all masonry reinforcement and slab reinforcement (WWF or reinforcing bar). Agent shall verify reinforcement has been chair/placed with proper clearances.
- B. The Owner shall employ a Testing Laboratory to inspect, sample and test the materials and the production of concrete and to submit test reports. Masonry testing shall be performed by

technicians certified by the Maine Concrete Technician Certification Board and/or ACI concrete field testing technician Grade I.

1. Verify that grouting operations are performed and grout is placed and consolidated in accordance with the specifications.
2. Verify that contractor is using approved admixtures for grout.
3. Sample Fresh Grout: ASTM C-172, except modified for slump to comply with ASTM C-94.
 - a. Slump: ASTM C-143; one (1) test for each grout load at point of discharge; one (1) test for each set of compressive strength test specimens.
 - b. Air Content: ASTM C-173; volumetric method or ASTM C-231 pressure method for normal weight concrete; one (1) for each of compressive strength test specimens.
 - c. Grout Temperature; For each load, at time of arrival, at point of discharge test hourly when air temperature is 40 degree F and above; and each time a set of compression test specimens are made.
 - d. Compression Test Specimens: ASTM C-31; one (1) set of four (4) standard cylinders for each truck or mixer load of grout taken when load is 50% discharged from truck, unless otherwise directed. Mold/store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
 - e. Refer to Section 033000, "Cast-In-Place Concrete" for remaining test requirements. Substitute therein the work "grout" for the word "concrete".
6. At the completion of the masonry portion of the Project, the Masonry Inspector shall submit a final report stating that all masonry work was, to the best of the Inspector's knowledge, in conformance with the Contract Documents and all applicable standards.

3.25 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. All exposed brick masonry shall be thoroughly cleaned. Before applying any cleaning agent to the entire wall, it shall be applied to a sample wall area of approximately 20 sq. ft. in a location approved by the Architect. No further cleaning work may proceed until the sample area has been approved by the Architect, after which time the same cleaning materials and method shall be used on the remaining wall area. Adequate water shall be available to thoroughly pre-soak and rinse all surfaces to be cleaned.
- E. All traces of excess mortar/grout, all efflorescence and all other construction stains shall be completely removed from exposed masonry.

END OF SECTION

SECTION 04 72 00
CAST STONE VENEER

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Architectural cast stone.
- B. Units required are:
 - 1. Exterior wall units, including wall caps, coping, lintels, sills, water tables, and cornices.
 - 2. Custom column caps and other shapes indicated per the Drawings.
 - 3. Other items indicated on the Drawings.

1.02 RELATED REQUIREMENTS

- A. Section 04 20 00 - Unit Masonry: Installation of cast stone in conjunction with masonry.
- B. Section 05 50 00 - Metal Fabrications: Loose steel lintels and embedded items.
- C. Section 07 92 00 - Joint Sealants: Sealing joints indicated to be left open for sealant.
- D. Section 07 21 00 - Thermal Insulation: Insulation for cavity spaces.
- E. Section 07 25 00 - Weather Barriers - Weather barrier and membrane flashings in cavity.
- F. Section 07 90 05 - Joint Sealers: Materials and execution methods for sealing soft joints in cast stone work.

1.03 REFERENCE STANDARDS

- A. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2011.
- B. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.
- C. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- D. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2012.
- E. ASTM C33 - Standard Specification for Concrete Aggregates; 2011a.
- F. ASTM C150 - Standard Specification for Portland Cement; 2012.
- G. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2012.
- H. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete; 2012.
- I. ASTM C642 - Standard Test Method for Density, Absorption, and Voids in Hardened Concrete; 2013.
- J. ASTM C 1194 - Compressive Strength of Architectural Cast Stone.
- K. ASTM C1364 - Standard Specification for Architectural Cast Stone; 2010b.
- L. Cast Stone Institute Technical Manual.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Manufacturer's Qualification Data: Documentation showing compliance with specified requirements.
- C. Product Data: Test results of cast stone components made previously by the manufacturer.
- D. Shop Drawings: Include elevations, dimensions, layouts, profiles, cross sections, reinforcement, exposed faces, arrangement of joints, anchoring methods, anchors, and piece numbers.
- E. Samples:

1. Submit mortar color selection samples.
 2. Selection Samples: Cast stone samples not less than 12 inches square, illustrating range of colors and textures being considered for this Project.
- F. Source Quality Control Test Reports.
- G. Manufacturer's Qualification Data: Documentation showing compliance with specified requirements.
- H. Warranty: Submit manufacturer's standard warranty.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A current producer member of the Cast Stone Institute with a minimum of 10 years of experience in producing cast stone of the types required for project.
- B. Source Quality Control: Test compressive strength and absorption of specimens selected at random from plant production.
1. Test in accordance with ASTM C642.
 2. Select specimens at rate of 3 per 500 cubic feet, with a minimum of 3 per production week.
 3. Submit reports of tests by independent testing agency, showing compliance with requirements.

1.06 MOCK-UP

- A. Mock-Ups: Provide cast stone masonry for exterior wall mock-up specified in Section 04 20 00 Unit Masonry.
1. Mock-up panel(s) shall be constructed in a timely manner to allow for review and modifications if necessary prior to start of any related construction.
 2. Mock-up panel(s) shall be of proper thickness, showing proposed masonry color range, texture, bond, mortar joint color and tooling, proper installation of various wall components, technical workmanship and aesthetic qualities of workmanship. No work shall progress until the Architect has reviewed the mock-up panel. Panel shall be revised as necessary to secure the Architect's acceptance.
 3. The panel(s) shall then become the standard of comparison for all masonry work built of the same material. The panel(s) shall not be destroyed or moved until the Work is complete and accepted by the Architect.
 4. Contractor shall remove mock-up panel(s) after exterior punch-list is completed.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cast stone components secured to shipping pallets and protected from damage and discoloration. Protect corners from damage.
- B. Number each piece individually to match shop drawings and schedule.
- C. Store cast stone components and installation materials in accordance with manufacturer's instructions.
- D. Store cast stone components on pallets with nonstaining, waterproof covers. Ventilate under covers to prevent condensation. Prevent contact with dirt.
- E. Protect cast stone components during handling and installation to prevent chipping, cracking, or other damage.
- F. Store mortar materials where contamination can be avoided.
- G. Schedule and coordinate production and delivery of cast stone components with unit masonry work to optimize on-site inventory and to avoid delaying the work.

PART 2 PRODUCTS

2.01 ARCHITECTURAL CAST STONE

- A. Cast Stone: Architectural concrete product manufactured to simulate appearance of natural stone, complying with ASTM C1364.

1. Compressive Strength, ASTM C1194: Greater than 6,500 psi at 28 days.
 2. Density, ASTM C 140: Greater than 120 pcf.
 3. Freeze-Thaw Resistance, ASTM C666: Less than 4 percent.
 4. Absorption ASTM C1195: Less than 6 percent at 28 days.
 5. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet.
 6. Color: Almond,
 7. Remove cement film from exposed surfaces before packaging for shipment.
 8. Products (Basis of Design):
 - a. Q-Stone by Shouldice Designer Stone
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Shapes and Sizes: Provide shapes specified here-in and as indicated on the Drawings.
1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch or length divided by 360, whichever is greater, but not more than 1/4 inch.
 2. Unless otherwise indicated on drawings, provide:
 - a. Wash or slope of 1:12 on exterior horizontal surfaces.
 - b. Drips on projecting components, wherever possible.
 - c. Raised fillets at back of sills and at ends to be built in.
 3. Shapes: (Basis of Design: Shouldice Designer Stone)
 - a. Window Header: Shouldice # 7 Keystone with left and right side Tapestry of nominal sections of 4x8x24 each. Provide sections in quantities as required for opening widths indicated per the Drawings.
 - 1) Application(s): Punched openings where indicated per the Drawings.
 - b. Cornice: 4x12x24 (nom) Tapestry.
 - 1) Application(s): Top of Wall - Tower, connector, mid-wall auditorium and as indicated per the Drawings.
 - c. Watertable: Tapestry # 824 Watertable.
 - 1) Application(s): Tower Level 4 and as indicated per the Drawings.
 - d. Wall Cap: Gem Stone "Emerald"
 - 1) Application(s): Top of wall at auditorium & canopy and as indicated per the Drawings.
 - e. Column Base Capital: Custom shapes and dimensions per the Drawings.
 - 1) Application(s): Farmers porch.
 - f. Wall Caps: Custom shapes and dimensions per the Drawings.
 - 1) Application(s): Terrace walls.
- C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI 318.

2.02 MATERIALS

- A. Portland Cement: ASTM C150.
 1. For Units: Type I, white or gray as required to match Architect 's sample.
 2. For Mortar: Type I or II, except Type III may be used in cold weather.
- B. Coarse Aggregate: ASTM C33/C33M, except for gradation; granite, quartz, or limestone.
- C. Fine Aggregate: ASTM C33/C33M, except for gradation; natural or manufactured sands.
- D. Admixtures: ASTM C494.
- E. Water: Potable.
- F. Reinforcing Bars: ASTM A615 deformed bars, galvanized or epoxy coated.
- G. Steel Welded Wire Reinforcement: ASTM A185, galvanized or epoxy coated.
- H. Embedded Anchors, Dowels, and Inserts: Type 304 stainless steel, of type and size as required for conditions.

- I. Shelf Angles and Similar Structural Items: Hot-dip galvanized steel per ASTM A123/A123M, of shapes and sizes as required for conditions.
- J. Mortar: Portland cement-lime, ASTM C 270, Type S. See Section 04 20 00.
- K. Sealant: As specified in Section 07 90 05.
- L. Weep Holes, Flashings, Wall Drainage Baffle: See Section 04 20 00 - Unit Masonry.
- M. Cleaner: General-purpose cleaner designed for removing mortar and grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; approved for intended use by cast stone manufacturer and by cleaner manufacturer for use on cast stone and adjacent masonry materials.

2.03 FABRICATION

- A. Fabricate stone masonry units using Vibrant Dry Tamp Casting method. Do not use dark mineral admixtures in surfaces intended to be exposed to view.
- B. Cure units in 95% moist environment at a minimum temperature of 70 degrees F for 16 hours after casting. Yard cure units at 95% humidity for 350 degree-days prior to shipping.
- C. Fabrication Tolerances:
 - 1. Cross Section Dimensions: Do not deviate by more than plus or minus 1/8 inch from approved dimensions.
 - 2. Length of Units: Do not deviate by more than length/360 or plus or minus 1/8 inch, whichever is greater, not to exceed plus or minus 1/4 inch.
 - 3. Warp, Bow, or Twist: Do not exceed length/360 or plus or minus 1/8 inch, whichever is greater.

2.04 SOURCE QUALITY CONTROL

- A. Mix Designs: Test new and existing mix designs for compressive strength and absorption before manufacturing cast stone units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine construction to receive cast stone components. Notify Architect if construction is not acceptable.
- B. Do not begin installation until unacceptable conditions have been corrected.

3.02 INSTALLATION

- A. Install cast stone components in conjunction with masonry, complying with requirements of Section 04 20 00.
- B. Mechanically anchor cast stone units indicated; set remainder in mortar.
- C. Setting:
 - 1. Drench cast stone components with clear, running water immediately before installation.
 - 2. Set units in a full bed of mortar unless otherwise indicated.
 - 3. Fill vertical joints with mortar.
- D. Joints: Make all joints 3/8 inch, except as otherwise detailed.
 - 1. Rake mortar joints 3/4 inch for pointing.
 - 2. Remove excess mortar from face of stone before pointing joints.
 - 3. Point joints with mortar in layers 3/8 inch thick and tool to a slight concave profile.
 - 4. Leave the following joints open for sealant:
 - a. Head joints in top courses, including copings, parapets, cornices, sills, and steps.
 - b. Joints in projecting units.
 - c. Joints between rigidly anchored units, including soffits, panels, and column covers.
 - d. Joints below ledge and relieving angles.
 - e. Joints labeled "expansion joint".

- E. Installation Tolerances:
 - 1. Variation from Plumb: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet or more.
 - 2. Variation from Level: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet, or 3/8 inch maximum.
 - 3. Variation in Joint Width: Not more than 1/8 inch in 36 inches or 1/4 of nominal joint width, whichever is less.
 - 4. Variation in Plane Between Adjacent Surfaces (Lipping): Not more than 1/16 inch difference between planes of adjacent units or adjacent surfaces indicated to be flush with units.
- F. Repairs: Repair chips and other surface damage noticeable when viewed in direct daylight at 20 feet.
 - 1. Repair with matching touchup material provided by the manufacturer and in accordance with manufacturer's instructions.
 - 2. Repair methods and results subject to Architect 's approval.

3.03 CLEANING

- A. Clean completed exposed cast stone after mortar is thoroughly set and cured.
 - 1. Wet surfaces with water before applying cleaner.
 - 2. Apply cleaner to cast stone in accordance with manufacturer's instructions.
 - 3. Remove cleaner promptly by rinsing thoroughly with clear water.
 - 4. Do not use acidic cleaners.

3.04 PROTECTION

- A. Protect completed work from damage.
- B. Clean, repair, or restore damaged or mortar-splashed work to condition of new work.

END OF SECTION

SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed steel stud exterior wall framing.
- B. Exterior wall sheathing.

1.02 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel Framing.
- B. Section 04 20 00 - Unit Masonry: Veneer masonry supported by CFMF stud wall.
- C. Section 04 72 00 - Manufactured Stone Masonry: Veneer masonry supported by CFMF stud framing.
- D. Section 06 10 54 - Wood Blocking and Curbing: Wood blocking.
- E. Section 07 25 00 - Weather Barriers: Weather barrier over sheathing.
- F. Section 09 21 16 - Gypsum Board Assemblies: Interior metal stud partition, soffit and ceiling framing.

1.03 REFERENCE STANDARDS

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012.
- B. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. current edition.
- C. ANSI S200 - North American Standard for Cold-Formed Steel Framing - General Provisions.
- D. ANSI S211 - North American Standard for Cold-Formed Steel Framing-Wall Stud Design.
- E. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- F. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
- G. ASTM A1003 - Standard Specification for Steel Sheet, Carbon, Metallic-Coated and Non-metallic-Coated for Cold-Formed Framing Members; 2005.
- H. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch to 0.112 inch in Thickness; 2004.
- I. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2004.
- J. ASTM C1177 - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2008.
- K. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other Sections that is to be installed in or adjacent to the metal framing system, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide data on standard framing members and fasteners; describe materials and finish, product criteria, limitations .
 - 1. Provide manufacturer's data on factory-made framing connectors, showing compliance with requirements.
- C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, and type and location of fasteners, and accessories or items required of related work. All shop drawings shall bear the seal of the licensed structural engineer employed by the CFMF subcontractor, licensed in the State where the Project is being constructed.
 - 1. Indicate stud layout.
 - 2. Describe method for securing studs to tracks and for bolted framing connections.
 - 3. Provide design engineer's stamp on shop drawings.
 - 4. Provide calculations for loadings and stresses of all framing that bear the seal of the licensed structural engineer employed by the CFMF subcontractor, licensed in the State where the Project is being constructed.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications:
 - 1. Company specializing in manufacturing the types of products specified in this Section, and with minimum fifteen years of documented experience.
 - 2. Member in good standing of the Steel Framing Industry Association. Products shall be certified under an independent third party inspection program administered by an agency accredited by IAS to ICC-ES AC98 IAS Accreditation Criteria for Inspection Agencies.
- C. Installer Qualifications: Company specializing in performing the work of this Section with minimum five years of experience.

1.07 MOCK-UPS

- A. Provide metal stud framing for exterior wall mock-up(s) specified in Section 04 20 00 - Unit Masonry.
 - 1. Mock-up panel(s) shall demonstrate actual wall construction, detailing and workmanship.
 - 2. No work shall progress until the Architect has reviewed the mock-up panel(s). Panel(s) shall be revised as necessary to secure the Architect's acceptance and shall then become the standard of comparison for all related exterior wall work.
 - 3. Mock-up panel(s) shall not be destroyed or moved until the Work is complete and accepted by the Architect. Upon completion of construction, mock-up panel(s) shall be removed.

1.08 PRE-INSTALLATION MEETING

- A. At least two weeks prior to start of installation of metal framing systems, meet at project site with installers of other work including door and window frames and mechanical and electrical work. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Protect and store metal framing units from rusting and damage in accordance with AISI Code of Standard Practice. Deliver to project site in manufacturer's unopened containers or bundles, fully identified with name, brand, type, and grade. Store off ground in a dry ventilated space or protect with suitable waterproof covering.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Framing:

1. Dietrich Metal Framing.
2. Marino\Ware .
3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FRAMING SYSTEM

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.
- B. Design Criteria: Provide completed framing system having the following characteristics:
 1. Design: Calculate structural characteristics of cold-formed steel framing members according to AISI S-100 North American Specification for the Design of Cold-Formed Steel Structural Members.
 2. Structural Performance: Design, engineer, fabricate, and erect to withstand specified design loads for project conditions within required limits.
 3. Design Loads: See Structural Drawings for design load criteria for this Project.
 - a. In accordance with applicable codes.
 4. Live load deflection meeting the following, unless otherwise indicated:
 - a. Horizontal Deflection: Design to permit maximum deflection of 1/720 of span of framing supporting masonry veneer exterior walls.
 - b. Vertical Deflection: Design framing to accommodate deflection of the structural steel framing members.
 5. Provide industry standard safety factors as suited to specific job conditions.
 6. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
 7. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.03 FRAMING MATERIALS

- A. Studs and Track: ASTM A1003 sheet steel, structural grade, Type H; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
 1. Thickness: As required to meet specified performance levels, but in no case less than 43 mils thickness.
 2. To the extent that component types and thicknesses are indicated in the Contract Documents, they shall be considered minimum requirements to be verified and increased (but not decreased) as determined to be necessary by the fabricator's engineer. Framing member depths indicated on the Drawings shall not be altered without the Architect's prior written authorization.
 3. Stud spacing shall not exceed 16 inches on center.
 4. Galvanized in accordance with ASTM A653 G60/Z180 coating.
- B. Framing Connectors: Factory-made formed steel sheet, ASTM A 653 SS Grade 50, with factory punched holes.
 1. Material: ASTM A653 SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for thicknesses less than 10 gage (0.118 inch), and factory punched holes and slots.
 2. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
 3. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
 - a. Where continuous studs bypass elevated floor slab, connect stud to slab in manner allowing vertical movement of slab without affecting studs; allow for minimum movement of 3/4 inch.

- b. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical movement of slab without affecting studs; allow for minimum movement of 3/4 inch.
4. Channel Bridging and Bracing: U-channel; minimum 0.0538" thickness; minimum 0.5" wide flanges; depth as indicated or required.
5. Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, gusset plates, and stiffeners.

2.04 WALL SHEATHING

- A. Wall Sheathing: Glass mat faced gypsum; ASTM C1177, square long edges, 5/8 inch Type X fire-resistant.
 1. Products:
 - a. DensGlass Gold by Georgia-Pacific.
 - b. Fiberock Sheathing with Aqua-Tough by USG.
 - c. GlasRoc Sheathing Type X by Certainteed - BPB America Inc.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
- B. Plates, Gussets, Clips: Formed Sheet Steel, thickness determined for conditions encountered; finish to match framing components.
- C. Clips (For securing head tracks to structural components intended to receive sprayed-on fireproofing): Galvanized steel, depth as required for thicknesses of fireproofing, size and thickness as determined by CFMF system engineering.
- D. Sill Gaskets: Continuous 1/4" thickness closed cell foam from continuous rolls, for use under CFMF tracks on concrete at building perimeters.
- E. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of Authorities Having Jurisdiction.
- F. Weather Barrier: As specified in Section 07 25 00.

2.06 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Size, type, penetration and spacing shall be in strict accordance with the CFMF contractor's engineered design requirements.
 1. Coating: Corrosion resistant, high performance polymer complying with ASTM B117; salt spray test result of no rust or other base metal corrosion after a minimum of 800 hours.
 2. Products:
 - a. XT-1000 by Scorpion.
 - b. Lifecoat by Hilti.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Anchorage Devices: Powder actuated. Welding is NOT allowed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.02 INSTALLATION OF STUDS

- A. Install components in accordance with manufacturers' instructions and ASTM C 1007 requirements.
- B. Install sill gaskets continuously on perimeter concrete surfaces, prior to track installation.

- C. Install continuous tracks sized to match studs. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches on center. Provide fasteners at corners and ends of tracks. Coordinate installation of sealant with floor and ceiling tracks.
- D. Place studs plumb, at 16 inches on center; not more than 2 inches from abutting walls and at each side of openings. Connect studs to tracks using fastener method.
- E. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- F. Abutting Structure: Where stud system abuts structural column or walls, including masonry walls, anchor ends of stiffeners to supporting structure.
- G. Install load bearing studs full length in one piece. Splicing of studs is not permitted.
- H. Install load bearing studs, brace, and reinforce to develop full strength and achieve design requirements.
- I. Wall Openings: Frame wall opening larger than 2 feet square with additional studs (2 minimum) at each jamb of frame as required by the engineered design. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes and space jack studs same as full-height studs of wall.
- J. Install intermediate studs above and below openings to align with wall stud spacing.
- K. Secure studs to top and bottom runner tracks by screw fastening at both flanges. Provide deflection head track directly below horizontal building framing at non-load bearing framing.
- L. Supplementary Framing: Install supplementary framing, blocking and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the walls or partitions. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations, engineering and industry standards in each case, considering weight or loading requirements resulting from item supported.
- M. Attach cross studs to studs for attachment of fixtures anchored to walls.
- N. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- O. Touch-up damaged galvanized surfaces with primer.

3.03 WALL SHEATHING

- A. General: Inspect materials to which gypsum sheathing is to be applied. Remedy all defects prior to installation of sheathing. Provide additional studs and bracing if required to secure sheathing at outside corners.
- B. Wall Sheathing: Cut sheathing by scoring or sawing. Gypsum sheathing shall be fitted tightly to abutting sheathing. All joints shall be closed tight. Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
 - 1. Coordinate sheathing installation with requirements of the air barrier system. If gaps in sheathing exceed requirements of Section 07 25 00 - Weather Barriers, they shall be taped.
- C. Sheathing shall be held in firm contact with substrate while fasteners are being driven. Sheathing shall be fastened as determined and detailed by the engineered design. Unless otherwise indicated, space fasteners a maximum of 8 inches o.c. around perimeter and in field at framing locations. Care shall be taken not to break sheathing face while driving fasteners.
- D. Fastening Sheathing: Gypsum board at exterior walls may be an integral part of the structural lateral stud bracing of the masonry veneer. Coordinate with the requirements of the engineered design.
 - 1. Exterior stud walls not indicated to receive interior gypsum board (to be left as exposed studs) shall be provided with additional blocking and bracing as required by the engineered design to stiffen the walls as if they had received gypsum boards.

3.04 TOLERANCES

- A. Maximum Variation from True Position: 1/8 inch per 10'.
- B. Maximum Variation of any Member from Plane: 1/8 inch per 10'.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated miscellaneous steel items, including but not limited to:
 - 1. Frames, brackets and supports for:
 - a. Part-height partition braces (shop-fabricated or manufactured).
 - b. Supports for other equipment as indicated.
 - c. hardware, mechanical equipment, and electrical equipment.
 - d. overhead doors.
 - 2. Loose lintels not furnished under Section 05 12 00 - Structural Steel.
 - 3. grating, bollards, pit covers and frames, elevator sill supports, corner guards, and counter supports.
 - 4. Roof edge blocking supports.
- B. It shall be a requirement of the Work of the Section to thoroughly review all of the Contract Documents and provide any and all miscellaneous metal fabrications required for a complete and proper job.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.
- B. Section 04 20 00 - Unit Masonry: Placement of metal fabrications in masonry.
- C. Section 04 72 00 - Cast Stone Veneer: Placement of metal fabrications in masonry.
- D. Section 05 12 00 - Structural Steel.
- E. Section 05 51 00 - Metal Stairs.
- F. Section 08 36 00 - Overhead Doors
- G. Section 09 91 13 - Exterior Painting: Paint finish.
- H. Section 14 20 10 - Passenger Elevators.

1.03 REFERENCE STANDARDS

- A. ASTM A36 - Standard Specification for Carbon Structural Steel; 2008.
- B. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- C. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.
- D. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- E. ASTM A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2012.
- F. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2010.
- G. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010a.
- H. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2010.
- I. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).
- J. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).
- K. SSPC-SP; Society for Protective Coatings; 1982 (Ed. 2004).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit for manufactured products specified herein.
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Submit lintel fabrication schedule including location, type, size, length and finish (primed or galvanized coating class).
- D. Certifications:
 - 1. Submit seismic analysis certification sealed and signed by a registered professional structural engineer in the State in which the Project is located, that all equipment stands, frames, and supports comply with applicable codes.
 - 2. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.
 - 3. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.
 - 4. Submit documentation of steel fabricator's in-plant special inspections program including registration of special inspections program, written procedural and quality control manuals and evidence of periodic auditing of fabrication practices by an approved inspection agency.
- E. Samples: Submit samples representative of materials and finished products as may be requested by the Architect.

1.05 QUALITY ASSURANCE

- A. Fabricator's Qualifications: Only fabricators that maintain an agreement with an approved independent inspection or quality control agency to conduct periodic in-plant inspections at the fabricator's plant, at a frequency that will assure the fabricator's conformance to the requirements of the inspection agency's approved quality control program will be approved for this project.
- B. Design equipment supports under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- C. Welding Standards: Comply with applicable provisions of ASW D1.1 "Structural Welding Code - Steel" and ASW D1.3 "Structural Welding Code - Sheet Steel".

1.06 PRODUCT HANDLING

- A. Delivery of Materials: Deliver, store and handle components in such a manner as to prevent damage to finished surfaces.
- B. Storage of Materials: Store components in a dry, clean location, away from uncured masonry and concrete. Cover with tarpaulin or polyethylene sheeting.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A500/A500M, Grade B cold-formed structural tubing.
- C. Plates: ASTM A 283.
- D. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.
- E. Slotted Channel Framing: ASTM A653 Grade 33, electro-galvanized steel metal channel framing and ASTM A1011 channel fittings system; engineered, fabricated and installed by the manufacturer's authorized installer with a minimum of five (5) years of experience. Installation shall include:

1. Field inspection to verify job conditions, dimensions, and suitability of primary structure to receive channel framing.
2. Engineering of all channel framing, attachments between framing members, attachments between framing systems and building structure, and anchor points to receive attachments by the manufacturer of the building material or equivalent to be supported by the channel framing systems.
3. Coordination of framing load capacity and anchor point types and locations with the requirements of the related material or equipment manufacturer.
4. Submission of structural calculations including, but not limited to design criteria, stress and deflection analysis and selected framing, fittings and anchors prepared by a professional structural engineer licensed in the State of Maine.
5. Manufacturer: Unistrut Corp.
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Fasteners: ASTM B33, Class FE/An 25 for electro-plated zinc coating, for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.
 1. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components.
 2. Machine Screws: ANSI B18.6.3.
 3. Lag Bolts: ANSI B18.2.1.
 4. Expansion Anchors: Carbon steel components zinc-plated to comply with ASTM B633.
- G. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- I. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. NOTE: It is the Owner's intent to use energy conserving, environmentally friendly materials to the greatest extent practical. The Contractor is therefore encouraged to use recycled steel products.
- B. Metal fabrications shall be standard approved products, fabricated in accordance with best shop practices and, wherever possible, shop assembled, ready for erection.
- C. Metals shall be free from defects impairing strength, durability, or appearance and shall be best commercial quality for purposes specified. Metals shall be made with structural properties, to safely sustain and withstand strains, stresses, to which they will be normally subjected.
- D. Fit and shop assemble items in largest practical sections, for delivery to site.
- E. Fabricate items with joints tightly fitted and secured.
- F. Continuously seal joined members by continuous welds.
- G. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- H. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- I. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED ITEMS

- A. Miscellaneous Framing and Supports: Provide steel framing and supports for applications indicated that are not a part of structural steel scope as required to complete the Work. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent construction. Fabricate from steel shapes, plates, and steel bars of welded construction using mitered joints for field connections. Cut, drill, and tap units to receive hardware, hangers, and

similar items. Equip units with integrally welded anchors for casting into concrete or building into masonry.

1. Part-height Stud Partition Posts: Support frame and post assembly shall be completely concealed within the wall partition. Posts shall be fabricated for attachment of adjacent metal studs, with welded baseplates and holes for expansion bolting to concrete floor slabs. Partition heights shall be as indicated on the Drawings. Framing shall support all partition loads as indicated in Section 09 21 16 - Gypsum Board Assemblies.
 2. Counter supports: Support frame and post assembly shall be completely concealed within the counter assembly and adjacent wall partitions. Framing system shall support 100 lbs per linear foot of counter length for 24 inch deep counters. Coordinate with counter assembly configuration as indicated on the Drawings.
- B. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.
1. Unless otherwise indicated on the Drawings, bollards shall be six (6) inches diameter galvanized Schedule 40 steel pipe and shall be not less than 3'-6" exposed above finish grade.
 2. At bollards secured to concrete slabs, provide 3/8" thick steel base plates for bolting to slab with 3/4" diameter anchors at all four corners; with continuously welded 1/4 inch thick steel cap.
- C. Door Frames for Overhead Door Openings: Channel sections; galvanized finish.
- D. Roof Perimeter Blocking Fastening Requirements:
1. Perimeter roof blocking shall be secured to decking, structural steel, spaced steel angles, or plates, as indicated on the Drawings.
 2. The Contractor shall provide additional steel angles and plates to suit specific job conditions.
 3. Where joist or beams do not extend out to roof edge, provide single or back to back steel angles or steel plates welded to perimeter steel beams in configurations indicated on the Drawings or otherwise required for support of blocking at 2'-0" o.c. intervals. Provide pre-drilled holes in steel for bolting of blocking at 24" o.c. with 1/2" bolts.
- E. Pit Covers and Frames:
1. Unless otherwise indicated on the Drawings, steel pit covers shall be 1/4" thick galvanized steel checkerplate. Frames shall be appropriately sized galvanized steel angles with suitable stops and anchoring devices.
- F. Abrasive nosings: For exterior concrete stairs shall be abrasive-surfaced, cross-hatched, cast iron nosings, 3" wide, Style 820 for steel pan stairs by American Safety Tread. Provide counter-sunk loose steel anchor.
- G. Loose Steel Lintels
1. Loose lintels shall be fabricated from A-36 steel from angles, shapes and masonry anchors of size and type scheduled for openings in masonry walls, unless otherwise indicated on the Drawings.
 2. Provide not less than eight (8") inches bearing at each side of openings, unless otherwise indicated. Under no circumstances shall bearing (each end) be less than one (1") inch per foot of span.
 3. Loose lintels, unless specifically otherwise noted, shall be installed with long legs vertical.
 4. All exterior wall lintels shall be hot-dipped galvanized after fabrication. Back-to-back lintels shall have exposed seams continuously welded and ground smooth prior to galvanizing.
 5. Lintels shall be required over all openings in masonry walls, including openings required for all other trades (i.e. mechanical and electrical equipment and ductwork, etc.), except where CMU lintels are otherwise scheduled or detailed.
 6. Loose Steel Lintel Schedule:

Max. Masonry	Wall Thickness	Wall Thickness
Openings	4 Inch Walls	6 Inch Walls
2' - 0" (& under)	1L 3-1/2 x 3-1/2 x 1/4	2Ls 3-1/2 x 2-1/2 x 1/4

3' - 0"	"	"
4' - 0"	1L 4 x 3-1/2 x 1/4"	
5' - 0"	"	2Ls 3-1/2 x 2-1/2 x 5/16
6' - 0"	1L 5 x 3-1/2 x 1/4"	
	Wall Thickness	Wall Thickness
	8 Inch Walls	12 Inch Walls
2' - 0" (& under)	2Ls 3-1/2 x 3-1/2 x 5/16	3Ls 3-1/2 x 3-1/2 x 5/16
3' - 0"	"	"
4' - 0"	2Ls 4 x 3-1/2 x 5/16	3Ls 4 x 3-1/2 x 5/16
5' - 0"	"	"
6' - 0"	2Ls 5 x 3-1/2 x 5/16	3Ls 5 x 3-1/2 x 5/16

2.04 FINISHES - STEEL

- A. Shop Primer: Shop prime painted for field finishing.
 1. Paint all steel items, except as indicated.
 - a. Exceptions: Galvanize items to be embedded in concrete, items to be imbedded in masonry, items specified for galvanized finish, and galvanized.
 - b. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
 2. Preparation:
 - a. Prepare exterior steel surfaces to be primed in accordance with SS PC-SP6 Commercial Blast Cleaning Standard.
 - b. Prepare interior steel to be primed and steel to be fireproofed in accordance with SS PC-SP3 Power Tool Cleaning Standard.
 - c. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
 3. Prime Paint: One coat shop standard primer, 2 - 3 mils DFT.
- B. Galvanizing of Steel Members: Galvanize after fabrication to ASTM A123 requirements by a member of the American Galvanizers Association, Inc with a high grade, non-lead zinc bath. Provide minimum 1.7 oz/sq ft galvanized coating.
 1. Smoothness: galvanizing shall a rugosity of 4 or less (16-20 microns of variation) when measured by a profilometer over a 1 inch straight line on the surface of elements that are less than 24 pounds per running foot. Profilometer shall be capable of operating in 1 micron increments.
 2. All hot-dipped galvanized material shall be stamped to indicate ASTM designation and ounces per square foot of zinc coating required by the specifications.
 3. Warranty: Galvanizer's standard warranty that materials shall be free from 10% or more visible rust for 20 years.
 4. Where hot-dip galvanizing prior to completion of fabrication (cutting or welding operations) cannot be avoided, joints and cuts shall be finished with four (4) full coats of touch-up galvanizing repair paint as recommended by the fabricator.
- C. Shop-applied Primer over Galvanized Steel: Shop sand-blast cleaned to SP-6 standard and shop prime.
 1. Primer: One coat Tnemec 90-97, 2 - 3 mils DFT.
- D. Factory-applied Architectural Finish over Galvanized Steel:
 1. Application(s): Exposed Metal Fabrications provided in coordination with exterior balconies, Juliette balconies and terrace areas.
 2. Hot-dip galvanizing: See paragraph above. Rugosity standards shall be met.
 3. Clean galvanized surface to create an acceptable profile for coating. If blasting is required rugosity standards shall be met.
 4. Primer: Factory-applied polyamide epoxy primer applied within 12 hours after galvanizing in-plant and in a controlled environment.

5. Finish Coat: Factory-applied color pigmented high performance architectural finish applied in-plant in a controlled environment.
6. Fade: Loss of gloss in excess of 35 units of gloss, per ASTM D523-89 with 60 degrees geometry.
7. Color Shift: Not to exceed 15 DE CIE LAB units for whites and light colors. Dark colors not to exceed 25 DE CIE LAB units (yellows, oranges, and reds excluded) per ASTM D2244.
8. Warranty: Provide galvanizer's standard warranty that materials shall be free from 10% or more visible rust for 20 years. Warranty for the finish gloss and color shall be 10 years in accordance with the fade performance specifications.
9. Product: Colorgalv 10 by Duncan Galvanizing.

2.05 FABRICATION TOLERANCES

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

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work. Coordinate all work with the work of other trades.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.
- C. Shearing and punching shall leave clean true lines and surfaces. Weld or rivet permanent connections. Welds and flush rivets shall be finished flush and smooth on surfaces that will be exposed after installation. Welds shall be continuous unless otherwise noted. Welds shall not have voids or pockets and shall be ground to provide smooth transitions between metal surfaces. Do not use screws or bolts where they can be avoided; where used, heads shall be countersunk, screwed up tight and threads nicked to prevent loosening.
- D. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water. Provide holes and connections for the work of other trades.
- E. Connections and accessories shall be adequate to safely sustain, withstand stresses, strains, to which they will be normally subjected.
 1. Connections to steel unless otherwise specified shall be steel.
 2. Connections to genuine wrought iron work shall be wrought iron or steel.
 3. Connections to cast iron, unless otherwise specified shall be steel.
 4. Bolts, nuts, screws for exterior work shall be electrogalvanized, unless otherwise noted.
- F. Furnish all standard screws, bolts, washers, and other such fastening devices as are necessary for attaching this work to other materials. Anchors and other connecting devices required in concrete or masonry shall be built-in as the work progresses. NOTE: Special attention shall be given to the firm and secure anchoring of overhead mounted materials and equipment.
- G. Do cutting, punching, drilling, tapping required for attachment of other work coming in contact with miscellaneous metal where so indicated or where directions for same are given prior to or with review of shop drawings.
- H. Unless otherwise indicated, bolt, and screw heads shall be flat countersunk in exposed faces of ornamental or finished character; elsewhere as required. Cut off bolts, screws, etc., where

exposed, flush with nuts, or other adjacent metal. Except as otherwise required, weld shop-assembled connections; welds, bolts, or machine screws may be used for field connections. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous. Exposed fastenings shall be the same materials, color, and finish as metal to which they apply, unless otherwise required.

- I. Make up threaded connections tightly so that threads will be entirely concealed by fittings.
- J. Allow for thermal movement resulting from a maximum temperature range change of 120 degrees F ambient and 180 degrees F surface by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night time sky heat loss.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects. All work shall be designed for adjustment to field variation, fitted with proper joints and intersections, adequately anchored in place.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Perform field welding in accordance with AWS D1.1.
- D. Obtain approval prior to site cutting or making adjustments not scheduled.
- E. Work to be built in with masonry shall be of form required for anchorage, or be provided with suitable anchors, expansion shields, toggle bolts, etc. as required for proper anchorage. Fastening to wood plugs in masonry shall not be permitted.
- F. Install all supporting members, fastening, framing, hangers, bracing, brackets, straps, bolts, angles, and the like required to set, connect work rigidly and properly to structural steel, masonry, other construction.
- G. Setting bearing plates: Clean concrete and masonry bearing surfaces of bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates. Set bearing and leveling plates on wedges, shims or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- H. Bollard Installation:
 - 1. Anchor with post-installed anchors and bolts. Provide four 3/4 inch anchors at each bollard, unless otherwise indicated. Embed anchors at least 4 inches into existing concrete.
- I. Stair Nosing Installation: Install with anchorage system indicated to comply with manufacturer's written instructions. Center nosings on tread widths and align nosings flush with riser faces and level with tread surfaces.
- J. Grating Frames: Fabricate frames and supports from structural steel shapes, plates and bars to sizes, shapes and profiles indicated and as necessary to receive gratings. Unless otherwise indicated, space anchors 24" o.c.
- K. Immediately after erection, clean field welds, bolted connections and abraded areas of shop paint, and paint exposed areas with the same materials as used for shop painting, complying with SSPC-PA1. Apply by brush or spray to provide a minimum 2 mil dry film thickness. Clean field welds, bolted connections and abraded areas of galvanized surfaces to comply with ASTM A780.

3.04 TOLERANCES

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

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

SECTION 05 51 00
METAL STAIRS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stairs with concrete filled treads.
- B. Prefabricated stairs.
- C. Structural steel stair framing and supports.
- D. Handrails and Guardrails.
- E. Railings and guards at roof terrace and exterior balconies.
- F. Steel ladder.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete fill in stair pans; mesh reinforcement for landings.
- B. Section 03 30 00 - Cast-in-Place Concrete: Placement of metal anchors in concrete.
- C. Section 04 20 00 - Unit Masonry: Placement of metal fabrications in masonry.
- D. Section 05 12 00 - Structural Steel.
- E. Section 05 50 00 - Metal Fabrications: Miscellaneous metal fabrications, factory applied architectural finishes.
- F. Section 07 72 00 - Roof Accessories: Rooftop guards.
- G. Section 09 90 00 - Painting and Coating: Field applied paint finish.
- H. Section 14 20 10 - Passenger Elevators: Pit ladder.

1.03 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ANSI A14.3 - Ladders Fixed and Safety Requirements.
- C. ASTM A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling; 2012.
- D. ASTM A36 - Standard Specification for Carbon Structural Steel; 2008.
- E. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- F. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.
- G. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- H. ASTM A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2012.
- I. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2010.
- J. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010a.
- K. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2007.
- L. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.

- M. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2012a.
- N. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
- O. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.
- P. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.
- Q. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2010.
- R. NAAMM AMP 510 - Metal Stairs Manual; The National Association of Architectural Metal Manufacturers; 1992, Fifth Edition.
- S. NAAMM MBG 531 - Metal Bar Grating Manual; The National Association of Architectural Metal Manufacturers; 2009.
- T. NAAMM MBG 532 - Heavy Duty Metal Bar Grating Manual; 2009 (ANSI/NAAMM MBG 532).
- U. OSHA 1910.27 - Fixed Ladders.
- V. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).
- W. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Submit stair, ladder and railing shop drawings drawn at not less than 1/4" scale with components shown in related positions. Provide larger scale custom details. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Show all required field dimensions.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Include the design engineer's stamp or seal on each sheet of shop drawings.
 - 3. Indicate points of support and loads imposed on supporting structure.
 - 4. Shop drawings shall indicate all components, both custom fabricated and manufactured products. Review drawings with cable railing manufacturer before submitting to Architect.
- C. Submit structural analysis and certification sealed and signed by a qualified professional structural engineer, licensed in the State in which the Project is being built, that the stairs, platforms, ladders, and railings comply with the required structural design loads.
- D. Submit fabricator's certification that the stairs, platforms and railings provided are in full compliance with the requirements of the Contract Documents and are totally suitable for the proposed installations when installed in accordance with the Shop Drawings.
- E. Submit evidence of the steel fabricator's in-plant special inspections program including: registration of special inspections program, written procedural and quality control manual and evidence of periodic auditing of fabrication practices by an approved inspection agency.
- F. Welders' Certificates.

1.05 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.
- B. Welder Qualifications: Show certification of welders employed on the Work, verifying AWS qualification within the previous 12 months.

- C. A company specializing in manufacturing products specified in this Section, with not less than ten years of documented experience.
- D. Fabricator's Qualifications: Fabricator shall be a certified member of ASIC or a member of SSFNE, who participates in a recognized quality assurance program and who is regularly inspected by an independent testing/inspection agency.
 - 1. In the absence of the above requirements, the fabricator shall be required to hire and pay for an independent testing/inspection agency, approved by the Owner, to monitor fabrication and perform random testing of all stair and railing fabrication procedures, and to report to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle components in such a manner as to prevent damage to finished surfaces. Store components in a dry, clean location, away from uncured masonry and concrete.

1.07 STRUCTURAL REQUIREMENTS

- A. Structural Design: Provide complete stair and railing assemblies complying with applicable codes.
- B. Stairs and Platforms: Engineer, fabricate and install steel stairs and platforms in accordance with NAAMM Metal Stair Manual and to withstand the following structural loads without exceeding the allowable design working stress of the materials involved. Apply each load to produce the maximum stress in each component of steel stairs.
- C. Stair Treads, Platforms and Framing: Live load in excess of 100 lb/sq ft and a concentrated load of 300 lb on an area of 4 square inches located in the center of the tread, whichever produces the greater stress, with deflection of stringer or landing framing not to exceed 1/360 of span. Stair framing shall be rigid, free of vibration and able to withstand stresses resulting from loads specified above as well as stresses resulting from railing system loads.
- D. Handrail and Guardrail Assemblies: Comply with ASTM E 985, ASTM E894, and withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component.
 - 1. Handrails shall be rigid, free of vibration and able to withstand a concentrated force of 200 pounds applied at any point in any direction and, but not simultaneously, a uniform load of 50 pounds per foot applied in any direction.
 - 2. Top Guardrail member shall be rigid and able to withstand a concentrated force of 200 pounds applied at any point and in any direction and, but not simultaneously, a uniform load of 100 pounds per foot applied vertically downward to the top of the guard.
 - a. Infill areas of guardrails shall be rigid and able to withstand a horizontal concentrated force of 200 pounds applied on one square foot at any point in the system including panels, intermediate rails, balusters, or other elements. This loading condition shall not be applied simultaneously with the other loading conditions for guardrails.
 - b. Guardrail System shall withstand stresses resulting from railing system loads specified above.
- E. Ladders: Engineer, manufacture and install ladders to support in excess of 300 pounds force concentrated live load.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 - 1. Regulatory Requirements: Provide stairs and railings complying with the most stringent requirements of local, State, and federal regulations; where requirements of the Contract Documents exceed those of regulations, comply with the Contract Documents.

2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
 3. Dimensions: As indicated on Drawings.
 4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 6. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
 - a. Welded Joints: Continuously welded and ground smooth and flush.
 - b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
 - c. Exposed Edges and Corners: Eased to small uniform radius.
 - d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
 - e. Application: Stair B (ST-B); Garage Level thru Second Floor Level.
 2. Commercial: Exposed joints as inconspicuous as possible, whether welded or mechanical; underside of stair not covered by soffit IS considered exposed to view.
 - a. Welded Joints: Intermittently welded on back side, filled with body putty, and sanded smooth and flush.
 - b. Welds Exposed to View: Ground smooth and flush.
 - c. Mechanical Joints: Butted tight, flush, and hairline.
 - d. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts.
 - e. Exposed Edges and Corners: Eased to small uniform radius.
 - f. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for satin or matte finish.
 - g. Application: Typical unless otherwise indicated.
 3. Industrial: All joints made neatly.
 - a. Welded Joints: Welded on back side wherever possible.
 - b. Welds Exposed to Touch: Ground smooth.
 - c. Bolts Exposed to Touch in Travel Area: No nuts or screw threads exposed to touch.
 - d. Application: Stairways within Main Electrical Room G013.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH CONCRETE TREADS

- A. Type: straight
- B. Risers: Closed.
- C. Treads: Metal pan with field-installed concrete fill.
 1. Concrete Depth: 1-1/2 inches, minimum.
 2. Tread Pan Material: Steel sheet.
 3. Tread Pan Thickness: As required by design; 10 gage inch minimum.
 4. Concrete Reinforcement: Welded wire mesh.
 5. Concrete Finish: For Paint finish.
- D. Risers: Same material and thickness as tread pans.
 1. Riser/Nosing Profile: Sloped riser with rounded nosing of minimum radius.
 2. Nosing Depth: Not more than 1-1/2 inch overhang.
 3. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch wide.
- E. Stringers: As detailed on the Drawings.
 1. Stringer Depth: As indicated on drawings.
 2. End Closure: Sheet steel of same thickness as risers welded across ends.

- F. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.
- G. Railings: Steel pipe railings.
- H. Finish: Shop prime painted.
- I. Under Side of Stair: Exposed to view, to be finished same as specified for other exposed to view surfaces.

2.03 PREFABRICATED STAIRS

- A. Alternating Tread Stairs: Welded metal unit; factory fabricated to the greatest degree possible.
 - 1. Design Requirements:
 - a. Stair Load Capacity: Support the following without exceeding the allowable working stress of the material.
 - 1) Single Point Load: 1000 pounds.
 - 2) Distributed Load: 100 pounds per square foot.
 - b. Guardrail and Handrail Capacity: Support the following without exceeding the allowable working stress of the material.
 - 1) Single Point Load: 200 pounds.
 - 2) Distributed Load: 50 pounds per linear foot.
 - c. Support the following without exceeding the allowable working stress of the material.
 - 1) Single Point Load: 1000 pounds.
 - 2) Distributed Load: 100 pounds per square foot.
 - 2. Materials: Aluminum; ASTM B221 (ASTM B221M), 6063 alloy, T52 temper.
 - a. Stair Angle: 68 degrees,
 - b. Components: Manufacturer's standard handrails, guardrails, non-skid treads and stringers.
 - c. Finish: Manufacturer's standard safety yellow powder coat.
 - d. Accessories: Manufacturer's standard foot divider with rubber bumper strip.

2.04 HANDRAILS AND GUARDRAILS

- A. Steel Wall-Mounted Rails: Round pipe rails unless otherwise indicated.
 - 1. Outside Diameter: 1.66 inch. (actual)
 - 2. Clearance: Minimum 2-1/4 inch from walls, protrusions and obstructions.
- B. Steel Guardrails:
 - 1. Location: Interior Stairways and ramps.
 - a. Top and Bottom Rails: Round pipe or tube rails unless otherwise indicated.
 - 1) Outside Diameter: 1.9 inch. (actual)
 - b. Infill at Picket Railings: Vertical pickets.
 - 1) Horizontal Spacing: Maximum 4 inches on center.
 - 2) Material: Solid steel bar.
 - 3) Shape: Round.
 - 4) Size: 1/2 inch diameter.
 - 5) Top Mounting: Welded to underside of top rail.
 - 6) Bottom Mounting: welded to top surface of bottom rail. See Drawings.
 - c. Steel End and Intermediate Posts: Same material and size as top rails.
 - 1) Horizontal Spacing: As indicated on Drawings and as required for structural requirements.
 - 2) Mounting: Welded to top surface of stringer.
 - 2. Location: Rooftop terraces and exterior balconies.
 - a. Top Rails: Oval pipe or tube rails unless otherwise indicated.
 - 1) Diameter: 1-1/2 inches (center).
 - 2) Outside Width: 3 inches.
 - b. Intermediate Horizontal Rails:
 - 1) Width: 4 inches.

- 2) Thickness: 1/2 inch and as required for structural requirements.
- c. Infill at Picket Railings at Balconies:
 - 1) Horizontal Spacing: Maximum 4 inches on center.
 - 2) Material: Solid steel bar.
 - 3) Shape: Round.
 - 4) Size: 1/4 inch diameter.
 - 5) Top Mounting: Welded to underside of intermediate plate.
 - 6) Bottom Mounting: Welded to top surface of bottom plate rail
- d. Infill at Picket Railings at Roof Terraces:
 - 1) Vertical Spacing: Maximum 4 inches on center.
 - 2) Material: Solid steel bar.
 - 3) Shape: Square.
 - 4) Width: 2 inches.
 - 5) Thickness: 1/2 inch and as required for structural requirements.
- e. Steel End and Intermediate Posts:
 - 1) Horizontal Spacing: As indicated on Drawings and as required for structural requirements.
 - 2) Mounting: Welded to top surface of cast in deck structural plate.
 - 3) Width: 2 inches.
 - 4) Thickness: 1/2 inch and as required for structural requirements.

2.05 LADDERS

- A. Steel Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish.
 1. Side Rails: 3/8 x 2 inches members spaced at 20 inches.
 2. Rungs: one inch diameter solid round bar spaced 12 inches on center.
 3. Space rungs 7 inches from wall surface.
 4. Field Finish: See Section 09 90 00 - Painting and Coating.

2.06 MATERIALS

- A. Steel Sections: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A500/A500M or ASTM A501 structural tubing, round and shapes as indicated.
- C. Steel Plates: ASTM A6 or ASTM A283.
- D. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.
- E. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
 1. Hot-Rolled Steel Sheet: ASTM A1011, Designation CS (commercial steel).
 2. Cold-Rolled Steel Sheet: ASTM A1008, Designation CS (commercial steel).
- F. Galvanized Steel Sheet: ASTM A653 Structural Steel (SS) Grade 33/230 with G40/Z120 coating.
- G. Concrete Fill: Type specified in Section 03 30 00.
- H. Concrete Reinforcement: Mesh type as detailed, galvanized.

2.07 ACCESSORIES

- A. Steel Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
- B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- C. Railing Fittings: All fittings for exterior applications shall be galvanized. Typical fittings shall include # 938 weld on caps, # 665 and # 1665 wall returns, # 386 and # 1386 brackets, by Julius Blum and Co. or equivalent.

- D. Gate Hinges (for gates at stairs and security railings): Self-closing, gravity pivot hinges, Type 7512 by Bommer or equivalent. Provide safety stops to prevent gates from swinging in the wrong direction.
- E. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- F. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.08 SHOP FINISHING

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Prime Painting: Tnemec 10-1009 Grey at 2-3 mils DFT.
 - 1. Preparation of Steel: Interior steel in accordance with SSPC-SP 3 Power Tool Cleaning Standard Exterior steel in accordance with SSPC-SP6 Commercial Blast Cleaning Standard.
 - 2. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
 - 3. Product: One coat shop standard primer, 2 - 3 mils DFT.
- D. Galvanizing: Hot-dip galvanize to minimum requirements of ASTM A123.
 - 1. Smoothness: Galvanizing shall a rugosity of 4 or less (16-20 microns of variation) when measured by a profilometer over a 1 inch straight line on the surface of elements that are less than 24 pounds per running foot. Profilometer shall be capable of operating in 1 micron increments.
 - 2. All hot-dipped galvanized material shall be stamped to indicate ASTM designation and ounces per square foot of zinc coating required by the specifications.
 - 3. Warranty: Galvanizer's standard warranty that materials shall be free from 10% or more visible rust for 20 years.
 - 4. Where hot-dip galvanizing prior to completion of fabrication (cutting or welding operations) cannot be avoided, joints and cuts shall be finished with four (4) full coats of touch-up galvanizing repair paint as recommended by the fabricator.
 - 5. Touch up abraded areas after fabrication using specified touch-up primer for galvanized surfaces.
 - 6. Applications: As indicated on the Drawings and all exterior railings shall be galvanized.
- E. Factory-applied Architectural Finish over Galvanized Steel:
 - 1. Location(s): Roof terraces, exterior balconies and exterior Juliette balconies or as indicated on the Drawings.
 - 2. Hot-dip galvanizing: See paragraph above. Rugosity standards shall be met.
 - 3. Clean galvanized surface to create an acceptable profile for coating. If blasting is required rugosity standards shall be met.
 - 4. Primer: Factory-applied polyamide epoxy primer applied within 12 hours after galvanizing in-plant and in a controlled environment.
 - 5. Finish Coat: Factory-applied color pigmented high performance architectural finish applied in-plant in a controlled environment.
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.
 - 7. Fade: Loss of gloss in excess of 35 units of gloss, per ASTM D523-89 with 60 degrees geometry.
 - 8. Color Shift: Not to exceed 15 DE CIE LAB units for whites and light colors. Dark colors not to exceed 25 DE CIE LAB units (yellows, oranges, and reds excluded) per ASTM D2244.
 - 9. Warranty: Provide galvanizer's standard warranty that materials shall be free from 10% or more visible rust for 20 years. Warranty for the finish gloss and color shall be 10 years in accordance with the fade performance specifications.
 - 10. Product: Colorgalv 10 by Duncan Galvanizing.

2.09 RAILING FABRICATION - GENERAL

- A. In general, heights of handrails shall be 34 inches above nosings. Heights of guardrails shall be a minimum of 42 inches above finish floor, unless otherwise noted on the Drawings. Handrails shall be mounted to provide a minimum of 2-1/4 inch clear space to walls and other surfaces.
- B. Space intermediate balusters as indicated on the Drawings or as otherwise required to provide a maximum clear space between all members of less than four (4) inches. Space railing posts as indicated on the Drawings, and in accordance with railing engineering requirements.
- C. In general, handrails at stairs shall extend at least 12 inches beyond the top riser and at least 12 inches plus the width of one tread beyond the bottom riser. At the top, the handrail extension shall be parallel to the walking surface. At the bottom, the handrail shall continue to slope for a distance of the width of one tread from the bottom riser, with the remainder parallel to the walking surface.
- D. In general, handrails at ramps shall be parallel to the walking surface at all locations and shall extend at least 12 inches beyond the top of the ramp and at least 12 inches beyond the bottom of the ramp.

2.10 FABRICATION - GENERAL

- A. Fit and shop assemble components in largest practical sections, for delivery to site.
- B. Fabricate components with joints tightly fitted and secured.
- C. Stairs shall be fabricated such that the triangle formed between the tread, riser and bottom rail shall not allow a 4 inch sphere to pass.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each configuration required. Maintain cylindrical cross section of pipe throughout the entire bend without buckling, twisting, cracking or otherwise deforming.
- F. All exterior railings, fittings and brackets shall be hot-dipped galvanized after fabrication.
- G. Provide expansion joints in railings at intervals not to exceed forty (40) feet. Provide slip joints with internal sleeves extending two (2) inches beyond the joint on either side. Fasten the internal sleeve securely on one side only. Locate expansion joints within six (6) inches of posts.
- H. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- I. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- J. Fabricate components accurately for anchorage to each other and to building structure.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Verify that rough opening and structural support are properly prepared prior to beginning installation.

3.02 PREPARATION

- A. When field welding is required, clean and strip primed steel items to bare metal.
- B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels. All field joints at galvanized stairs and railings shall be bolted.
- F. Obtain approval prior to site cutting or creating adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.
- H. Where railings are to be set in concrete, railing posts shall be set in six (6) inch matching sleeves. Clean dust and foreign matter from sleeves and moisten interior of hole and surfaces with clean water. Pour fast setting cement into the annular space until it overflows the hole. Taper cement away from rails to promote proper drainage.
- I. Steel Stair Installation
 - 1. Set stair units accurately in location, alignment, and elevation, with edges and surfaces level, plumb and free of rack. Measure from established lines and levels.
 - 2. Install steel stairs by welding stair framing to steel structure or to weld plates cast into concrete and/or masonry except where otherwise indicated. Provide temporary bracing as required.
 - 3. Fit exposed connections accurately together to form hairline joints. Weld field connections of interior stairs. All field connections of exterior hot-dip galvanized coated stairs shall be bolted, do not weld, cut or abrade.
 - 4. Set steel stair base plates at masonry walls on wedges or other adjustable devices. After stairs have been positioned, tighten anchor bolts. Use nonmetallic, non-shrink grout and pack grout solidly between bearing surfaces and plates to ensure no voids remain.
 - 5. Completed stair installation shall be rigid and free from vibration.

3.04 TOLERANCES

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

3.05 FIELD QUALITY CONTROL

- A. General: Stair, ladder, landing and railing materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified testing agency. Such inspections and tests shall not relieve the Contractor of responsibility for providing his own inspections, quality control and materials and fabrication procedures in compliance with specified requirements. Any non-compliant materials or fabricated components shall be removed and replaced.
- B. The fabricator shall submit evidence of in-plant inspections in conformance with the International Building Code Structural Tests and Inspections - Inspection of Fabricators (1700).
- C. Testing and inspection shall be performed as required by the building code, the Contract Documents or as otherwise directed by the Architect. The cost of field testing and inspection shall be paid for by the Owner. If Work is found not to conform to the Contract Documents, the Contractor shall be responsible for the cost of all further testing.

- D. The Contractor shall cooperate with and facilitate testing and inspection in the field by the testing agency. The Contractor shall, at his own expense, furnish the testing agency stair, ladder and railing shop drawings. Field bolted and welded connections shall be inspected.

END OF SECTION

3. Ceiling Joint:
 - a. Through ceiling.
4. Intermediate Joint:
 - a. Butt joint with factory supplied alignment plates
5. Floor Joint:
 - a. Flush to floor.

2.03 FABRICATION

- A. Form column covers to specified dimensions and diameters as indicated on the Drawings.
 1. Provide column covers in detachable sections in a maximum 12'-0" tall per section. Provide additional sections to achieve finished heights above 12'0".
 2. Columns shall have no exposed fasteners unless specified.
 3. Fabricate ceiling ring to match column covers.
 4. Apply manufacture's recommended sound-deadening insulation to backs of column covers.

2.04 FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.
- B. Prefinished Stainless: Brushed # 4.
- C. Pre-finished Aluminum with Polycoat Gloss Finish:
 1. Pattern: Blendz..
 2. Color: Bamboo.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine job-site for conditions that may adversely affect installation of column covers.
- B. Verify dimensions of column covers prior to installation to ensure compatibility with job-site conditions.
- C. Verify post structure is plumb, level, and parallel prior to installation of column covers.
- D. Visually examine finished surfaces to ensure that blemished or dented surfaces are not present prior to installation.

3.02 PREPARATION

- A. Verify / Coordinate with other trades prior to installation where they may affect the column cover installation.

3.03 INSTALLATION

- A. Install components in accord with manufacturer's installation instructions and approved submittal drawings.
- B. Anchor components to related structures such as floors, walls and beams as indicated on approved submittals drawings. Use anchors with holding strength to provide a solid installation. Use only plated, galvanized or stainless steel anchors.
- C. Installer to provide additional bracing components as necessary to stiffen substructure and ensure solid mid-span bracings and connections.

3.04 CLEANING

- A. Remove protective coverings and clean column covers to remove adhesives and tape residue. Test all solvents on non-exposed surfaces prior to use.
 1. Protect column covers from damage during remainder of construction period

END OF SECTION

SECTION 06 10 54
WOOD BLOCKING AND CURBING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof nailers, perimeter blocking and curbs.
- B. Blocking for wall and roof openings.
- C. Fire retardant treatment of wood.
- D. Preservative treatment of wood.
- E. Isolation Strips (to separate preservative treated wood from metal surfaces).
- F. Telephone and electrical panel boards, not specified as part of Division 26 - Electrical.
- G. Concealed wood blocking for support of wall mounted items furnished by contractor and furnished by Owner, including, but not limited to: toilet and bath accessories, wall cabinets, wood trim, counters, grab bars, door bumpers, monitor and TV mounting brackets, healthcare rails, and millwork items.
- H. Thermal Barrier Closure Plate.

1.02 RELATED SECTIONS

- A. Section 04 20 00 - Unit Masonry: Masonry openings to receive wood blocking.
- B. Section 04 72 00 - Cast Stone Veneer: Cast Stone Veneer openings to receive wood blocking.
- C. Section 05 40 00 - Cold-Formed Metal Framing: Window and door openings to receive wood blocking.
- D. Section 07 53 23 - Ethylene-Propylene-Diene-Monomer Roofing (EPDM).
- E. Section 07 54 00 - Thermoplastic Membrane Roofing (TPO).

1.03 REFERENCES

- A. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- B. AWPA U1 - Use Category System: User Specification for Treated Wood; 2013.
- C. PS 1 - Structural Plywood, 2009.
- D. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology; 2010.
- E. SPIB - Grading Rules; Southern Pine Inspection Bureau, Inc.; 2002 and supplements.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials.
- C. Certifications: Submit wood preservative treated manufacturer's certifications that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing and finishing treated materials.
 - 1. Submit verification of compliant moisture content for waterborne treated products.
 - 2. Submit warranties from chemical treatment manufacturers for each type of treatment.
- D. Submit dimension lumber certificates indicating compliance with minimum allowable unit stresses. Indicate species and grade selected for each used and design values approved by the American Lumber Standards Committee Board of Review.

1.05 MOCK-UPS

- A. Provide blocking materials in wall mock-up as specified in Section 04 20 00 – Unit Masonry.

- B. Mock-up panels shall demonstrate actual wall construction, detailing and workmanship. Finish materials shall be of the proper thickness, showing proposed color range, texture, bond, joints, and workmanship.
- C. No work shall progress until the Architect has reviewed the sample panels. Panels shall be revised as necessary to secure the Architect's acceptance. The panels shall then become the standard of comparison for all related exterior wall work.

1.06 QUALITY ASSURANCE

- A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
 - 1. Acceptable Lumber Inspection Agencies: Any agency with rules approved by American Lumber Standards Committee. Inspection agencies shall include: NLGA, SPIB, WCLIB, WWPA. Lumber shall be piece factory-marked with agency grade stamp.
 - 2. Lumber of other species or grades, or graded by other agencies, is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
- B. Plywood: Comply with PS 1.
- C. Coordination with other Trades: Coordinate the locating of blocking, nailers, and similar supports for finish materials, millwork, casework, finish carpentry, equipment, hardware and accessories, regardless of whether such items are Owner or Contractor furnished, so that the installation of finish work may be properly executed in compliance with the intended design requirements. Before starting installation of supports, carefully check all related shop drawings and submittals.

PART 2 PRODUCTS

2.01 DIMENSION LUMBER

- A. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).
- B. Nominal sizes as indicated on drawings, S4S, kiln dried.
- C. Miscellaneous Blocking, Furring, Nailers, and Curbs:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
- D. Wood Nailers (Roof): PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
 - 1. Width: 3-1/2 inches, nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.
 - 2. Thickness: See Drawing details.

2.02 PLYWOOD PANELS

- A. Plywood Sheathing: PS-1 APA rated; Grade C-C, Exterior Exposure; Fire Retardant.
- B. Miscellaneous Panels:
 - 1. Concealed Plywood: APA rated sheathing, PS-1, C-C Plugged or better, exterior grade, thickness as indicated.
 - 2. Exposed Plywood: PS-1, A-C or better, interior grade, thickness as indicated.
 - 3. Electrical Component Mounting: APA rated sheathing, PS-1, C-C Plugged, not less than 15/32 inch thickness.

2.03 ACCESSORIES

- A. Thermal Barrier Closure Plate: 26 gauge mill finish sheet aluminum at fiberglass window rough openings and other penetrations where indicated in the Drawings for NFPA 285 compliance.
- B. Fasteners and Anchors:
 - 1. Fastener Coatings:
 - a. Hot-dipped galvanized steel per ASTM A 153/A 153M or AISI Type 304 stainless steel for exposed to weather or high humidity locations.

- b. AISI Type 304 stainless steel at preservative treated wood locations, as appropriate to suit job conditions.
- c. Hot-dipped galvanized nails per ASTM A653, Class G185.
2. Anchors: Expansion shield and lag bolt type for anchorage to solid masonry or concrete. Expansion anchors shall conform to Federal Specification FF-S325.
 - a. Anchors shall be capable of sustaining without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by ASTM E488.
 - b. Materials: Carbon-steel, zinc plated, ASTM B633, Class FE/Zn5, or Stainless-steel with bolts and nuts, ASTM F593 and ASTM F594, Alloy Group 1 or 2.
3. Lag Screws and Lag Bolts: Shall conform to Federal Specification FF-B-561 and ASME B18.2.1.
4. Power Driven Fasteners; Shall conform to National Evaluation Report NER-272.
5. Nails and Staples: Shall conform to Federal Specification FS-N-105 and ASTM F1667.
6. Bolts: Shall conform to Federal Specifications FF-B-571 and FF-B-575, ASTM A307, Grade A and ASTM A563 for hex nuts and flat washers.
7. Ground Anchorage: Wood plugs or nailing blocks are not acceptable for fastening grounds, furring, etc. to concrete or masonry. Hardened steel nails, expansion screws, toggle bolts, metal plugs, or metal inserts, as most appropriate for each type of masonry or concrete construction shall be used.
8. Isolation Strips: (At preservative treated framing in contact with metals): Self-adhesive membrane flashing, see below, cut to width of wood framing, continuous.

2.04 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWWA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- B. Fire Retardant Treatment, Exterior Type: AWWA U1, Use Category UCFB, Commodity Specification H, chemically treated and pressure impregnated, capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84 and with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 1. Kiln dried after treatment to maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 2. Provide fire-retardant treated wood products in the following locations:
 - a. Wood exterior wall covering members located 40 feet and higher above ground plane.
 - b. Telephone, Electrical and other Utility panel boards.
 - c. Blocking within nonbearing exterior walls where no fire rating is required.
 - d. Wood lumber and plywood indicated to be Fire-Retardant Treated (F.R.T.) or Fire Retardant (F.R.) on the Drawings.
- C. Preservative Pressure Treatment of Lumber Above Grade: AWWA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.
 1. Kiln dry after treatment to maximum moisture content of 19 percent.
 2. Provide preservative pressure treated wood products in locations consistent with manufacturer's use recommendations. Locations as follows, not exposed to weather:
 - a. Wood in contact with roofing, flashing, or waterproofing.
 - b. Wood in contact with masonry or concrete.
 - c. Wood less than 18 inches above grade.

- d. Wood built into interior walls in wet areas.
- e. NOTE: Wood at surrounds of exterior doors and windows shall not be preservative treated when fully wrapped by flashing on the exterior face in conjunction with air/vapor barrier membranes.
 - 1) At exterior doors wood blocking within 18 inches of finish grade shall be preservative treated.
- f. Wood at locations as indicated to be P.T. on the Drawings.
- 3. Wood Preservative Types and Minimum Absorption Amounts:
 - a. CA-C - Copper Azole, Type C. (0.06 absorption)
 - b. ACQ - Alkaline Copper Quaternary. (0.25 absorption)
 - c. MCA - Micronized copper azole. (0.05 absorption)
 - d. PTI - Propiconazole-Tebuconazole-Imidacloprid. (0.018 absorption)
- D. Restrictions: Do not use lumber or plywood treated with chromated copper arsenate (CCA) or creosote.
- E. Isolation Strips: Self-adhering, polymer modified asphalt sheet, 40 mil thickness, with strippable release paper.
 - 1. Products:
 - a. Vycor V40 Tape.
 - b. Vycor Ice & Watershield.
 - c. Perm-A-Barrier Wall Membrane by W.R. Grace.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Examine and correct any conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected. Set members level and plumb, in correct position.
- B. Place horizontal members with crown side up.
- C. Construct curb members of single pieces.
- D. Space framing and furring members 16 inches o.c.
- E. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.
- F. Coordinate curb installation with installation of decking and support of deck openings.
- G. Provide miscellaneous members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- H. Cut out and discard all defects that will render a piece unable to serve its intended function. The Architect may reject lumber whether or not it has been installed, for excessive checking, warp, twist, bow, crook, mildew, fungus or mold as well as for improper cutting and fitting.
- I. Securely attach rough carpentry work to substrate by anchoring and fastening complying with CABO NER-272 for power-driven fasteners, and fastening schedules in the International Building Code, unless otherwise indicated.
- J. All preservative treated wood shall be separated from all aluminum and steel surfaces by use of flexible membrane isolation strips.

3.02 INSTALLATION OF PLYWOOD

- A. Secure with long dimension perpendicular to framing members, with ends over firm bearing and staggered, using nails, screws, or staples.
- B. Materials shall be applied according to recommendations of the American Plywood Association.

- C. Install telephone and electrical panel back boards made of plywood or other acceptable structural panels at locations indicated. Size back boards to be minimum 48 inches beyond size of telephone and electrical panels.
- D. All preservative treated plywood shall be separated from all metal (coated and uncoated) by use of isolation strips.

3.03 INSTALLATION OF WOOD BLOCKING

- A. Install all wood blocking as required to provide anchorage for other materials, fixtures, accessories, etc. Blocking shall be minimum 1-1/2" thick materials.
- B. Wedge, anchor and align blocking to provide a rigid and secure installation of both blocking and other work related thereto.
- C. All wall-mounted door stops and interior signage attached to gypsum wallboard surfaces shall have blocking within the supporting wall.
- D. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build anchor bolts into masonry during installation of masonry work wherever possible. Secure anchor bolts to formwork before concrete placement wherever possible.
- E. All preservative treated wood blocking shall be separated from all metal (coated and uncoated) by use of isolation strips.

3.04 INSTALLATION OF ROOF BLOCKING

- A. Roof blocking shall be installed in accordance with FM Loss Prevention Data 1-49. The following shall be considered the minimum requirements for anchoring roof blocking. Provide a minimum of two (2) anchors per length of each piece of blocking, and within six (6) inches of each end. The Contractor shall provide additional fasteners as needed to suit specific job conditions. Perimeter roof blocking shall be secured to decking, structural steel, spaced steel angles, or plates as described below unless indicated otherwise on the Drawings:
 - 1. Roof blocking parallel to metal decking ribs: Secure blocking to joists or beams with 3/8" diameter bolts at no more than 4'-0" oc. Where joist or beam spacing is greater than 4'-0", bolt blocking to a continuous steel angle secured to the structure at maximum spacing of 4'-0" o.c. welded to the structure. As an alternative method, blocking may be secured to the deck with two rows of #10 stainless steel screws at twenty-four (24) inches o.c. with 5/8 inch diameter stainless steel washers.
 - 2. Roof blocking perpendicular to metal decking ribs: Secure blocking to the deck with two rows of #10 stainless steel screws at twenty-four (24) inches o.c. with 5/8 inch diameter stainless steel washers.
 - 3. Roof blocking anchored to masonry: Secure blocking with 1/2 inch diameter bolts, spaced a maximum of four (4) feet o.c., staggered if the blocking is wider than six (6) inches. Within eight (8) feet of building corners, provide bolts at two (2) feet o.c. Bolts shall be embedded in grouted masonry cells a minimum depth of eight (8) inches.
 - 4. For nailing layers of blocking to each other, provide nails in two (2) rows, staggered with spacing not to exceed 12 inches o.c. within the row. Nails to secure blocking to other blocking shall be galvanized and shall be long enough to penetrate 1-1/4 inch minimum.
- B. Form blocking in conjunction with perimeter roof fascias and membrane roofs to shapes as detailed. Shim as required to continuously align flush with top of abutting roof insulation, including added thickness of tapered insulation, where applicable. Shim as required to maintain a constant top of fascia elevation, where applicable.
- C. All curbs and blocking related to roof hatches, mechanical equipment and other roof mounted accessories shall be installed level and plumb and shall not necessarily follow the pitch of the roof, unless specifically indicated on the Drawings.
- D. All preservative treated wood blocking shall be separated from all metals (coated and uncoated) surfaces by use of isolation strips.

3.05 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
- B. Allow preservative to dry prior to erecting members.

END OF SECTION

SECTION 06 20 00
FINISH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Custom woodwork items including but not limited to:
 - 1. Reception desks.
 - 2. Wood door frames.
 - 3. Wood trim and base.
 - 4. Adjustable wall shelving.
 - 5. End panels and cleats for counters.
 - 6. Mailbox units.
 - 7. Window sills.
 - 8. Fireplace mantels.
- B. Hardware and attachment accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: blocking.
- B. Section 06 41 00 - Architectural Wood Casework: Shop fabricated custom cabinet work.
- C. Section 09 90 00 - Painting and Coating: Painting finish carpentry items.
- D. Section 12 34 00 - Plastic Laminate Casework: Shop fabricated cabinet work.
- E. Section 12 36 00 - Countertops: Plastic laminate and solid surface countertops.

1.03 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2009.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- C. AWI/AWMAC/WI - Architectural Woodwork Standards; 2009.
- D. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood-Preservers' Association; 2012.
- E. ANSI/BHMA A156.9 - American National Standard for Cabinet Hardware; 2010.
- F. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2004.
- G. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.
- B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's technical information for all factory fabricated products, hardware, and accessories specified herein.
 - 2. Provide data on fire retardant treatment materials and application instructions.
- C. Shop Drawings: Indicate materials, elevations, construction, clearances, component profiles, fastening methods, jointing details, finishes, hardware locations and accessories.
 - 1. Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot.
 - 2. Provide the information required by AWI/AWMAC/WI (AWS).

- D. Samples:
1. Submit wood veneer panel samples minimum of 12 x 12 inch in size illustrating specified finish and full range of wood species grain and color.
 2. Submit wood trim samples minimum of 8 inches long, illustrating full range of grain and color.
 3. Submit confirmation samples of selected plastic laminate color chips.
 4. Submit hardware samples as requested by the Architect.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this Section with minimum five years of documented experience.
- B. Grade materials in accordance with the following:
1. Softwood Lumber: In accordance with rules certified by ALSC.
 2. Plywood: Certified by the American Plywood Association.
 3. Hardwood Lumber: In accordance with NHLA Grading Rules.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork and millwork during transit, delivery, storage and handling to prevent moisture and other damage, soiling and deterioration.
- B. Do not deliver woodwork and millwork until environmental conditions are suitable (enclosed, dry, with operating HVAC system), and painting and similar operations that could damage woodwork and millwork are complete.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

- A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI/AWMAC/WI Architectural Woodwork Standards for Premium Grade for hardwood veneer items and Custom Grade for plastic laminate faced items.
- B. Surface Burning Characteristics: Provide materials having fire and smoke properties as required by applicable code.
1. In general, finishes shall be Class A minimum in exits. Class B minimum in corridors and rooms.

2.02 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.03 LUMBER MATERIALS

- A. Standard Softwood Running Trim (for painting): Clear Pine species, maximum moisture content of 8%, based on Brosco Millwork Co. standard shapes and sizes as indicated per the Drawings.
- B. Hardwood Lumber (for painting): Poplar species, Plain sawn, moisture content of 5 to 10%.
1. MDF is NOT acceptable for painted trim.

2.04 SHEET MATERIALS

- A. Plywood is defined as a panel manufactured with 3 or more layers (plys) of wood products composed of outer veneers or overlays and core materials laminated into a single sheet or panel.
1. All plywood shall be manufactured in the United States or Canada.
 2. Cores shall comply with published industry standards for cores manufactured for use in architectural woodwork.
 3. Where a core is not specified, selection shall be at the option of the AWI woodworker.
- B. Panel Core for Plastic Laminate Facings: Medium density fiberboard; ANSI A208.2, class MD or MD-EXT as applicable, no urea formaldehyde-added, composed of wood chips, sawdust, or flakes of 47 pcf minimum density, made with water resistant adhesive; of grade to suit application; sanded faces.

1. Modulus of Elasticity: 405,000 psi minimum.
2. Screw Holding Face: 250 lbs minimum.
3. Screw Holding Edge: 225 lbs minimum.
4. Products - fire resistant:
 - a. Basis of Design: Medite FR by SierraPine Corp.
 - b. Georgia Pacific.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
5. Products - non-fire rated:
 - a. Basis of Design: Medex by SierraPine Corp.
 - b. Georgia Pacific.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 LAMINATE MATERIALS

- A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, indicated "P Lam" on the Drawings.. See Finish Legend for manufacturers and colors. All panels shall be faced both sides for balanced construction. Provide types for applications as follows:
 1. Horizontal Surfaces: HGL, 0.039 inch nominal thickness, .
 - a. Applications: Exposed horizontal surfaces.
 2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, .
 - a. Applications: Exposed vertical surfaces and semi-concealed surfaces.
 3. Liner: CLS, 0.020 inch nominal and matte surface texture.
 4. Laminate Backer: BKL; 0.020 inch nominal thickness; undecorated plastic laminate.
 - a. Applications: Concealed faces for balanced construction.
- B. Laminate Adhesive: Type recommended by laminate manufacturer to suit application; not containing formaldehyde or other volatile organic compounds.

2.06 FASTENINGS

- A. Adhesives: Suitable for the purpose; no urea formaldehyde or volatile organic compounds.
- B. Fasteners: Nails, screws and other anchoring devices of size, material, finish and type to suit application to provide secure attachment, concealed where possible; stainless steel or hot-dipped galvanized finish, complying with ASTM A153 in exposed locations of high humidity and at all exterior locations.
- C. Concealed Joint Fasteners: Threaded steel.
- D. Wall Panel Clip System: Aluminum 2 inch panel Z-clips for attachment of plastic laminate and wood faced panels to wall tracks.
 1. Continuous Wall Tracks: Extruded Aluminum wall tracks for horizontal installation.
 2. Shims: Multi-Polymer.
 3. Other components and hardware for a complete installation.
 4. Product:
 - a. Panel Clip Classic Anchor System by Brooklyn Hardware.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 ACCESSORIES

- A. Sealants: Comply with requirements of Section 07 90 00 - Sealants.
- B. Lumber for Shimmiing, Blocking, and Furring: Softwood or hardwood lumber, kiln dried to less than 15% moisture content.
- C. Edge Banding: PVC or ABS, 3 mm thickness, extruded flat shaped with eased edges; smooth finish; for machine application with hot melt adhesive; through colors; of width to match component thickness and length as required; multiple color as selected.
 1. Products:
 - a. Accent Edge by Woodtape.
 - b. Edge Banding by Charter Industries.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

- D. Primer: See Section 09 00 00 - Painting and Coating.

2.08 HARDWARE

- A. Hardware: BHMA A156.9. Basis of Design products indicated. For substitutions see Section 01 60 00 - Product Requirements.
- B. Shelf Standards & Brackets:
1. Super-duty; standards: 7/8" wide x 11/16" high x 14 gage cold rolled steel, single tracks, 2" slot spacing, back supported style, anochrome finish; bracket lengths as indicated on the Drawings. Note: one (1) bracket at each connection to standard location.
 - a. Product: 87 Standard and 186/187 Bracket by Knape & Vogt (KV).
 2. Furnish anochrome #154 shelf fasteners for wood shelves.
- C. Panel Support Clips: Interlocking metal Zee Clips. Total assembled clip thickness shall be 1/4".
- D. Coat Rods and Flanges: Heavy-duty; chrome finished steel.
1. Product: 1-1/16" diameter, # 770-1 rods, #734 / 735 flanges for 1-1/16 rods by Knape & Vogt.
- E. Wiring Grommets: 2" outside diameter; plastic. Color selected from manufacturer's full range.
1. Product: Series TG by Doug Mockett Co. Inc.
- F. Counter Support Bracket: Sizes as required for counter depth (8" to 29"). Spacing as indicated on the Drawings, but in no case greater than 36" apart.
1. Finish: Powder coat finish. Color as selected from manufacturer's standard range.
 2. Flush mount (vertical support leg secured directly to stud and concealed behind gypsum board).
 3. Product: EH-1800 Series by Rakks.
- G. Coat Hooks: Provide one per office door; #405 by Ives.
- H. Wire Shelving System: Adjustment height; vinyl coated steel heavy duty adjustable wall tracks, shelf tracks, shelf brackets, wire shelving units, hang rods, accessories, and other items required for a complete installation. Provide adequate number of standards and brackets to properly support full lengths of shelves without deflection under heavy loads.
1. Vinyl coating color to be selected by Architect from standard colors.
 2. Clothing and Coat Closets: 12" width; continuous freeslide shelving as indicated on Drawings for closets.
 3. Laundry Closets (12" width): Two continuous tight mesh shelves per closet.
 4. Product: Fast Track Adjustable Shelving System with Freeslide Shelving by Closetmaid.
 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.09 WOOD TREATMENT

- A. Factory-Treated Lumber: Comply with requirements of AWPA U1 - Use Category System for pressure impregnated wood treatments determined by use categories, expected service conditions, and specific applications.
- B. Fire Retardant Treatment (FR-S Type): Chemically treated and pressure impregnated; Class A, capable of providing flame spread index of 25 maximum for hardwoods and softwoods, fuel contributed index of 15 maximum for hardwoods and 25 maximum for softwoods, and smoke developed index of 0, maximum for hardwoods and 15 maximum for softwoods, when tested in accordance with ASTM E84
1. AWPA U1; cured organic resin solution, relatively insoluble in water and shall not bleed through or otherwise adversely affect types of finishes indicated. Treatment shall permit milling of lumber after treatment and kiln drying by a plant certified by U.L. Maximum moisture content shall meet treatment manufacturer's standards.

2.10 FABRICATION

- A. The millwork details represented on the Drawings are not intended to indicate all of the framing, blocking and panel support required for the proper installation of millwork. It shall be the

Contractor's responsibility to properly detail such work for lasting strength and stability, and to accurately represent it on shop drawings.

1. Note: There shall be no unfinished wood products. If not covered with plastic laminate products or otherwise finished, all wood surfaces shall be receive a minimum of one coat of sealer in concealed or semi-concealed areas.
- B. In general, woodwork shall be assembled and installed using concealed fasteners, unless otherwise approved by the Architect. Fasteners shall be concealed, blind nailed, or countersunk with matching plugs. Secure woodwork to anchors or blocking built-in or directly attached to substrates.
- C. Trim shall be fastened in place with finishing nails, set heads for putty. Woodwork shall be sanded as necessary to remove irregularities and machine marks. The use of finishing screws shall not be permitted. All work shall be left free of blemishes and defects.
- D. Joints in all work shall be tight and formed to conceal shrinkage. Running trim shall be in long lengths and joined only where solid fastenings can be made. End joints in built-up members shall be well distributed. Exterior corners shall be mitered, and interior corners and/or angles shall be coped. All edges shall be slightly eased; edges of solid wood members 3/4" thick or less to 1/16"; edges of rails and similar members more than 3/4" thick to 1/8".
- E. Complete fabrication in the shop, including assembly, finishing, and hardware application, to the maximum extent possible, before shipment to the site. Disassemble components only as necessary for shipment and installation. Pre-cut openings, where possible, to receive hardware, fixtures, electrical work and similar items.
- F. Fit exposed sheet material edges with edging as indicated on the Drawings. Use one piece for full length only.
- G. Condition woodwork to average prevailing humidity conditions in installation areas before installation. Install woodwork level, plumb, true and straight to a tolerance of 1/8" to 96 inches. Shim as required with concealed shims. Scribe and cut woodwork to fit, and refinish cut surfaces and repair damaged finish at plastic trim.
- H. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting. Closure panels/strips, end panels and trim shall be provided as required for a complete, finished installation.

2.11 PLASTIC LAMINATES

- A. Plastic laminates shall be installed in strict accordance with the manufacturer's recommendations. All edges shall be tooled smooth and square. Any scratched or defaced materials shall be completely replaced at no additional cost to the Owner. Where materials meet at edges and corners, joints shall butt and overlapping members shall be filed off smooth, forming a slightly eased joint.
- B. Cap exposed plastic laminate finish edges with plastic banding, or as detailed on the Drawings.
- C. Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners.
- D. Apply laminate backing sheet to reverse face of plastic laminate finished surfaces.

2.12 SHOP FINISHING

- A. Scope: It is intended that all millwork constructed of veneered and solid hardwood products shall be shop finished as specified herein. All painting shall be provided as a part of the Work of Section 09 90 00 - Painting and Coatings.
- B. Comply with referenced quality standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork. Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of wood work. Apply 2 coats to back of panels and to end grain surfaces.
- C. Sand work smooth and set exposed nails and screws.

- D. Finish work in accordance with AWI/AWMAC/WI (AWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Opaque:
 - a. System - 4, Latex Acrylic, Water-based.
 - b. Color: As selected by Architect.
 - c. Sheen: Semigloss.
- E. Field touchup after installation: Acrylic Lacquer.
- F. Back prime woodwork items to be field painted, prior to installation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this Section are placed and ready to receive this work.
- C. See Section 06 54 10 - Wood Blocking and Curbing, for installation of concealed wood blocking.

3.02 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.
- D. Install hardware in accordance with manufacturer's instructions.
- E. Adjustable Wire Shelving System: Install hang track continuous at elevation indicated and secure to blocking in wall as recommended by the manufacturer. Locate shelf tracks as indicated on the Drawings, but in no case more than 24" oc and within 4" of the end of shelves. Secure shelf tracks at approximately center of their length into blocking in the wall. Install brackets and shelving. Where shelving is required to be field cut, provide protective wire end caps. Installation shall be level, plumb and securely attached to the wall.
- F. Adjustable Shelf Standard and Brackets for millwork shelving: Install standards at locations indicated on the Drawings, but in no case greater than 32 inches o.c. and within 6" of the ends of shelves. Screw standards securely to blocking in the wall at a spacing recommended by the manufacturer for the shelf depth and load anticipated. Install brackets in standards at each shelf location.

3.03 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

3.04 CLEANING AND PROTECTION OF WORK

- A. Erect and maintain temporary protective barriers until such time as permanent construction is in place and all danger of damage or defacement is past.
- B. Repair damaged and defective woodwork, where possible to eliminate functional and visual defects. Where not possible to repair, replace woodwork. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop applied finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Cabinet hardware.
- C. Factory finishing.
- D. Preparation for installing utilities.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Concealed blocking.
- B. Section 06 20 00 - Finish Carpentry.
- C. Section 12 36 00 - Countertops.

1.03 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2009.
- B. ANSI A208.2 - American National Standard for Medium Density Fiberboard; 2009.
- C. AWI (QCP) - Quality Certification Program, www.awiqcp.org; current edition at www.awiqcp.org.
- D. AWI/AWMAC/WI - Architectural Woodwork Standards; 2009.
- E. ANSI/BHMA A156.9 - American National Standard for Cabinet Hardware; 2010.
- F. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- G. PS 1 - Structural Plywood; 2009.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Convene a pre-installation meeting not less than three before starting work of this Section; require attendance by all affected installers.
 - 1. Discuss wall cabinet cleat system, securement inspection and cabinet installation.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for panels, laminates, veneers and hardware accessories.
- C. Shop Drawings: Indicate materials, finishes, component profiles, thicknesses, fastening methods, jointing details, elevations, hardware locations, finishes and accessories.
 - 1. Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot.
- D. Samples:
 - 1. Submit samples of hardwood panels and running trim of selected species and finish.
 - 2. Submit samples of cabinet construction, minimum cabinet substrate and shop finish.
 - 3. Submit samples of pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this Section with minimum five years of documented experience.
 - 1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
- B. Quality Certification: Provide AWI Quality Certification Program (QCP) inspection report and quality certification of completed work.

1. Provide labels or certificates indicating that the work complies with requirements of AWS Grade or Grades specified.
2. Prior to delivery to the site provide shop drawings with certification labels.
3. Provide labels on each product when required by certification program.
4. Upon completion of installation provide certificate certifying that the installation and products meet the specified requirements.
5. Arrange and pay for inspections required for certification.
6. Replace, repair, or rework all work for which certification is refused.

1.07 PROJECT CONDITIONS

- A. Field Dimensions: The woodwork fabricator shall be responsible for coordinating the dimensions of all his work with actual field conditions, as well as with furniture, equipment and appliances to be furnished by others. The Contractor and fabricator shall cooperate to establish and maintain dimensions as required for a proper fit, without field modifications. Verify locations of concealed framing, blocking, reinforcements, and furring that support woodwork by accurate measurements before being enclosed.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect units during transit, delivery, storage, and handling to prevent moisture and other damage, soiling and deterioration.

1.09 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

- A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI//AWMAC/WI Architectural Woodwork Standards for Custom Grade.
- B. Cabinets:
 1. Finish - Exposed Exterior Surfaces: Decorative laminate.
 2. Finish - Exposed Interior Surfaces: Decorative laminate.
 3. Finish - Concealed Surfaces: Manufacturer's option.
 4. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
 5. Casework Construction Type: Type A - Frameless.
 6. Adjustable Shelf Loading: 50 lbs. per sq. ft..
 7. Cabinet Style: Flush overlay.
 8. Cabinet Doors and Drawer Fronts: Flush style.
 9. Drawer Construction Technique: Dovetail joints.

2.02 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.
- B. Panel Core for Plastic Laminate Facing: Particle Board (PB); ANSI A208.1; Class M2, type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated and herein; no urea formaldehyde-added, composed of wood fibers pressure bonded with water resistive adhesive to suit application; sanded faces; thicknesses as required.
 1. Density: 38.7 pcf minimum.
 2. Modulus of Elasticity: 290,100 psi minimum.
 3. Screw Holding Face: 202 lbs minimum.
 4. Screw Holding Edge: 180 lbs minimum.
- C. Panel Core for Plastic Laminate Facing: Medium density fiberboard (MDF); ANSI A208.2; Class MD, type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated and herein; no urea formaldehyde-added, composed of wood fibers pressure bonded with [adhesive] to suit application; sanded faces; thicknesses as required.

1. Applications: Moisture resistant type for cabinets, panels and aprons below sinks and where indicated on the Drawings.
 2. Density: 47 pcf minimum.
 3. Modulus of Elasticity: 405,000 psi minimum.
 4. Screw Holding Face: 250 lbs minimum.
 5. Screw Holding Edge: 225 lbs minimum.
- D. Panel thicknesses shall be as follows, unless otherwise indicated on the Drawings:
1. Cabinet Tops and Bottoms: 3/4"
 2. Cabinet Ends, Supports and Divider Panels: 3/4"
 3. All Shelves: 3/4" up to 36" long and 1" over 36" long.
 4. Concealed Cabinet Backs: 3/8".
 5. Exposed Cabinet Backs: 3/4".
 6. Exposed Panels: 3/4".
 7. Doors and Drawer Fronts: 3/4".
 8. Tall Cabinet Doors: 1".
 9. Stiles, Rails and Trim: 3/4".
 10. Cabinet Valances: 3/4".
 11. Cabinet Aprons: 3/4".
 12. Drawer Backs: 1/2".
 13. Drawer Bottoms: 3/8".

2.03 LAMINATE MATERIALS

- A. High Pressure Decorative Laminate (HPDL): NEMA LD 3; indicated as 'P Lam' on the Drawings. See Finish Legend for manufacturers and colors. All panels shall be faced both sides for balanced construction. Provide types for applications as follows:
1. Horizontal Surfaces: HGL, 0.039 inch nominal thickness,.
 - a. Applications: Exposed horizontal surfaces.
 2. VGS, 0.028 inch nominal thickness, .
 - a. Applications: Exposed and semi-exposed vertical and horizontal surfaces.
 3. Cabinet Liner: CLS, 0.020 inch nominal thickness, . Applications:
 - a. Applications: Semi-concealed reverse face of exposed surfaces, except as indicated.
 4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated.
 - a. Applications: Concealed faces.

2.04 COUNTERTOPS

- A. Countertops specified in Section 12 36 00 - Countertops.

2.05 ACCESSORIES

- A. Adhesive: Urea formaldehyde-free. Type recommended by fabricator to suit application.
- B. Edge Banding: Extruded PVC or ABS, flat shaped with eased edges; smooth finish; of width to match component width. Banding thickness as follows:
1. 3 mm applications: Door and drawer fronts, 4 sides; Cabinet body edges exposed; Shelf front edges exposed (healthcare shelves 4 sides).
 2. Color: As selected by Architect from manufacturer's standard range.
 3. Products:
 - a. Accent Edge by Dolken Woodtape.
 - b. Edge Banding by Charter Industries.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Mounting Cleats: Solid hardwood; species is fabricator's option.
- D. Fasteners: Size and type to suit application.
- E. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.

- F. Concealed Joint Fasteners: Threaded steel.
- G. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface. Products manufactured by Doug Mockett, Inc.
 - 1. Quantity and locations: Provide minimum one grommet per (4) four linear feet of work surface. Location of all grommets shall be determined by the Architect and Owner during shop drawing process.

2.06 HARDWARE

- A. Hardware: ANSI/BHMA A156.9, types as scheduled for quality grade specified. Where applicable, equal products as manufactured by Bommer, Ives, Stanley, Knape and Vogt, Hafele are acceptable. Finish of all hardware shall be US26D, unless otherwise indicated.
- B. Shelf Pin Supports: Standard side-mounted system using multiple holes for pin supports and coordinated self rests, anochrome finish, for nominal 1 inch spacing adjustments.
 - 1. Product: 345 by Knape and Vogt.
- C. Drawer and Door Pulls: "U" shaped wire pull, steel with satin finish, 4 inch centers.
 - 1. Product: 4484 by Stanley.
- D. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with satin finish.
 - 1. Product: 0737 by Corbin Lock.
- E. Catches: Magnetic. Use 2 on doors over 34" high.
 - 1. Product: SP41 by Stanley.
- F. Silencers: Use two per drawer or door.
 - 1. Products: Glynn Johnson #GJ65, Corbin #34 or Sargent #3445.
- G. Drawer Slides: Telescoping on ball bearings.
 - 1. Type: Extension types as scheduled.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self closing/stay closed type.
 - 6. Products:
 - a. 7432 by Accuride International, Inc
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Panel Support Clips: Interlocking metal Zee Clips. Total assembled clip thickness shall be 1/4".
- I. Wiring Grommets: 2" outside diameter plastic; colors as selected from full color range. Series TP by Doug Mockett Co.
- J. Hinges: Exposed barrel type, steel with satin finish.
 - 1. Product: Aximat SM by Hafele.

2.07 FABRICATION

- A. Cabinet Style: Flush overlay.
- B. Cabinet Doors and Drawer Fronts: Flush style.
- C. Drawer Construction Technique: Dovetail joints.
- D. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- E. Wall Cleats: Provide an interlocking wall cleat system at the top of wall cabinets. Interlocking cleats shall be 3/4" x 2-1/2" with 45 degree cut. Cabinet mounted cleat shall be glued and doweled to cabinet ends and glued to top and back of cabinet. The bottom cabinet cleat shall be secured to the cabinet similarly to the upper interlocking cleat. See Installation paragraph, for wall cleat mounting requirements. An interior clear dimension of 12" shall be maintained for wall cabinets, unless indicated otherwise on the Drawings.
- F. Edging: Fit shelves, doors, and all edges with specified edging. Exposed and semi-exposed edges do not use more than one piece for any single length.

- G. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- H. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
 - 1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
 - 2. Cap exposed plastic laminate finish edges with plastic trim.
- I. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.
- J. Note: There shall be no unfinished wood products. If not covered with plastic laminate products or otherwise finished, all wood surfaces shall be receive a minimum of one coat of sealer in concealed or semi-concealed areas.

2.08 SHOP FINISHING

- A. Scope: It is intended that all units shall be factory (shop) finished as specified herein.
- B. Sand work smooth and set exposed nails and screws.
- C. For opaque finishes, apply wood filler in exposed nail and screw indentations and sand smooth.
- D. Finish work in accordance with AWI/AWMAC/WI (AWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Opaque:
 - a. System - 3, Lacquer, Postcatalyzed.
 - b. Color: As selected by Architect.
 - c. Sheen: Flat.
- E. Finish work in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Section 1500, Premium, Conversion Varnish, Transparent.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing. Verify type of support framing for determination of proper fastener type. A minimum load of 60 pounds/LF for wall cabinets shall be supported. Provide a safety factor of 2.
- B. Verify location and sizes of utility rough-in associated with work of this Section.

3.02 INSTALLATION

- A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level. Install to a tolerance of 1/8" in 8'-0" for plumb and level and with 1/16" maximum offset in flush adjoining surfaces, 1/8" maximum offsets in revealed adjoining surfaces.
- B. Wall Cleat System:
 - 1. Wall mounted portion of the interlocking cleat system shall be secured to continuous 2x6 wood blocking concealed within the partition that is anchored to studs. Fasten wall cleat with #12 pan head or wood screws, minimum 2-1/2" long, maximum 8" on center, or a minimum of 2 per cabinet. Pre-drill holes in cleats. Cleat shall be a continuous piece where multiple cabinets are installed in a row.
 - 2. Wall cleat securement to wall blocking shall be inspected and confirmed by the Owner prior to proceeding with wall cabinet installation.
 - 3. Secure cabinet by first interlocking the cleat system. Secure cabinet to wall cleat with #12 wood screws, minimum 2-1/2" long, minimum 2 per cabinet per cleat at top cleat and at bottom cleat, following industry best practices.
 - 4. Provide finished cabinet end panel if required to conceal end of wall cleat.
- C. Use concealed joint fasteners to align and secure adjoining cabinet units.

- D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- E. Secure cabinets to floor using appropriate angles and anchorages. Scribe base toe-kick board to uneven floor surfaces.
- F. Countersink anchorage devices at exposed locations.
 - 1. Plastic Laminate Cabinet Interiors: Conceal with white plastic plugs.
- G. Install without distortion so that doors and drawers will fit openings properly and be accurately aligned.

3.03 ADJUSTING

- A. Adjust moving or operating parts to function smoothly and correctly.
- B. Touch-up finishes to restore damaged or soiled areas.

3.04 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

SECTION 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Bituminous dampproofing for the following applications:
 - 1. Structural steel columns and base plates in earth or concrete.
 - 2. Earth-covered face of site retaining walls with earth on one side and outdoor space on the other.
 - 3. Inside walls of exterior planters.
 - 4. Miscellaneous locations as indicated on the Drawings.

1.02 REFERENCE STANDARDS

- A. ASTM D1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal; 1997 (Reapproved 2011).
- B. ASTM D1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing; 2013.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide properties of primer, bitumen, and mastics.
- C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.04 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS

2.01 DAMPPROOFING PRODUCTS

- A. Bituminous Dampproofing: Cold-applied water-based emulsion; asphalt with mineral colloid or chemical emulsifying agent; with or without fiber reinforcement; asbestos-free; suitable for application on vertical and horizontal surfaces.
 - 1. Composition - Vertical Application: ASTM D1227 Type III or ASTM D1187 Type I.
 - 2. Composition - Horizontal and Low-Slope Application: ASTM D1227 Type II or III.
 - 3. VOC Content: Not more than permitted by local, State, and federal regulations.
 - 4. Applied Thickness: 1/16 inch, minimum, wet film.
 - 5. Products:
 - a. Sealmastic Emulsion Type II (brush/spray-grade) by WR Meadows Inc.
 - b. 220-AF Fibered Emulsion Dampproofing (brush or spray grade) by Karnak.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Primers, Mastics, and Related Materials: Type as recommended by dampproofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of dampproofing system.

- C. Verify that items that penetrate surfaces to receive dampproofing are securely installed.

3.02 PREPARATION

- A. Protect adjacent surfaces not designated to receive dampproofing.
- B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.
- C. Do not apply dampproofing to surfaces unacceptable to manufacturer. Do not apply over frost-covered surfaces.
- D. Apply mastic to seal penetrations, small cracks, or minor honeycomb in substrate.
- E. Use material as it comes in the container; thinning shall not be permitted.
- F. Do not apply dampproofing when temperature is below 40 degrees F.

3.03 APPLICATION

- A. Prime surfaces in accordance with manufacturer's instructions.
- B. Apply dampproofing in one coat, continuous and uniform, at a rate of 3 pounds/sq ft per coat.
- C. In general, dampproofing of retaining walls shall begin four (4) inches below finish grade and extend continuously to six (6) inches below level of finish grade on opposite side of wall.
- D. Seal items projecting through dampproofing surface with mastic. Seal watertight.
- E. Coordinate installation so that dampproofing may serve as mastic for insulation, where applicable.
- F. Immediately backfill against dampproofing to protect from damage.

END OF SECTION

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fluid applied membrane waterproofing.
 - 1. At earth-covered face of elevator pit walls.
 - 2. At earth-covered face of building walls with earth on one side and habitable space on the other.
- B. Drainage panels and Protection boards.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete substrate.
- B. Section 07 21 00 - Thermal Insulation: Insulation board.
- C. Section 07 54 00 – Thermoplastic Membrane Roofing: Coordination of waterproofing and roofing system membrane flashing at terrace area intersection.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.
- C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- D. Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer's Installation Instructions: Indicate special procedures.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of fluid-applied waterproofing membranes with fifteen years experience.
- B. Installer Qualifications: Company specializing in installation of fluid-applied waterproofing with minimum ten years experience.

1.06 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until cured.

1.07 WARRANTY

- A. See Section 01 78 00 - Warranties.
- B. All materials and workmanship related to sprayed-on applications shall be warranted, on a single document, by manufacturer and the licensed applicator for ten (10) years against defects and failures in products and installation.
- C. Repair and replacement: Such defective work, and other work damaged thereby which becomes defective during the warranty term, without extra cost to the Owner.

PART 2 PRODUCTS

2.01 MEMBRANE AND FLASHING MATERIALS

- A. Fluid-Applied Waterproofing (Sprayed-on): Polymer-enhanced, single component, black, elastomeric membrane for vertical surfaces only.
 - 1. Vertical Cured Thickness: 60 mils, minimum.
 - 2. Solids Content: 60%
 - 3. Suitable for installation over concrete substrates and green concrete without adverse effect on adhesion.
 - 4. VOC: Complies with VOC limits established by the South Coast Air Quality Management District (California).
 - 5. Application Temperature: minimum of 40 degrees F; down to 20 degrees F with approval of manufacturer.
 - 6. Cure Time: 16 to 24 hours.
 - 7. Adhesion: Exceeds ASTM C794.
 - 8. Elongation: 800% per ASTM D412.
 - 9. Water Vapor Permeance: 0.09 perms for 40 mil dry coat per ASTM E 96.
 - 10. Protection / Drainage Board: Quick Set Panels (QSP).
 - 11. Products: Tremproof 260 by Tremco Sealants & Waterproofing Inc.
 - 12. Substitutes: See Section 01 60 00 - Product Requirements.
- B. Flexible Flashings: Type recommended by membrane manufacturer.

2.02 ACCESSORIES

- A. Surface Conditioner: Compatible with waterproofing membrane as recommended by membrane manufacturer.
- B. Sealant for Joints and Cracks in Substrate: Type compatible with waterproofing material and as recommended by waterproofing manufacturer.
- C. Insulation Board: Rigid insulation specified in Section 07 21 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.
- C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.
- D. Verify that items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

- A. Protect adjacent surfaces not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.
- C. Do not apply waterproofing to surfaces unacceptable to manufacturer.
- D. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
- E. Seal moving joints and joints with sealant, not rigid filler, using procedures recommended by sealant and waterproofing manufacturers.
- F. Fill voids, honeycomb, rock pockets, etc with non-shrink grout as recommended by the waterproofing manufacturer. Allow patching materials to cure.

1. Repair and seal all cracks, non-moving control joints and penetrations per manufacturer's details and recommendations.

3.03 INSTALLATION

- A. Apply waterproofing in accordance with manufacturer's instructions to specified minimum thickness.
- B. Apply primer or surface conditioner at a rate recommended by manufacturer. Protect conditioner from rain or frost until dry.
- C. Apply waterproofing in accordance with manufacturer's instructions to specified minimum thickness.
- D. Coating may be applied to damp or green concrete. Do not apply to frozen surfaces.
- E. Apply waterproofing by co-spraying or by two coat application with a tack coat applied horizontally, followed by the topcoat applied vertically.
- F. Apply extra thickness of waterproofing material at corners, intersections, and angles.
- G. Install flexible flashings and seal into waterproofing material. Seal items penetrating through membrane with flexible flashings.
- H. Seal membrane and flashings to adjoining surfaces. Install termination bar at all edges. Install counterflashing over all exposed edges.

3.04 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

- A. Place protection board directly against set membrane as curing begins, starting at the bottom of the wall, butt joints. Supplement board adhesion to the membrane with adhesives or mechanical fasteners as recommended by the manufacturer. Scribe and cut boards around projections, penetrations, and interruptions.
- B. All surfaces shall be fully covered with protection board as recommended by the manufacturer.
- C. Place protection board directly against drainage panel; butt joints. Scribe and cut boards around projections, penetrations, and interruptions. See Section 07 21 00 for Board installation requirements.

3.05 PROTECTION

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

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rigid board insulation at cavity wall construction, perimeter foundation wall, and underside of floor slabs.
- B. Mineral fiber batt insulation in garage ceiling construction.
- C. Mineral fiber insulation used as thermal insulation where indicated in the Drawings.
- D. Acoustic insulation in interior partitions and under raised floor areas.
- E. Firesafing insulation.
- F. Sheet vapor retarders under concrete slab-on-grade.
- G. Foam insulation sealant.
- H. Adhesives, stick clips, tape, spring clips, etc.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Preparation to receive subsurface sheet vapor retarder.
- B. Section 04 20 00 - Unit Masonry.
- C. Section 04 72 00 - Cast Stone Veneer.
- D. Section 05 40 00 - Cold-Formed Metal Framing: Board insulation as wall sheathing.
- E. Section 07 25 00 - Weather Barriers: Separate air barrier and vapor retarder materials.
- F. Section 07 53 23 – Ethylene-Propylene-Diene-Monomer Roofing (EPDM): Insulation specified as part of roofing system.
- G. Section 07 54 00 - Thermoplastic Membrane Roofing: Insulation specified as part of roofing system.
- H. Section 07 84 00 - Firestopping: Safing insulation.
- I. Section 09 21 16 - Gypsum Board Assemblies: Partitions for acoustic insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- B. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2014.
- C. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- E. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials; 2010.
- F. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations. For foam plastic insulation board, submit manufacturer's NFPA 285 tested assembly data indicating compliance and coordination with other materials used in the wall assembly.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.
- E. Samples: Upon request, submit samples of each type of materials to be used.

1.05 MOCK-UPS

- A. Mock-Up(s): Provide insulation board for exterior wall mock-up(s) specified in Section 04 20 00 - Unit Masonry
- B. Mock-up panels shall demonstrate actual wall construction, detailing and workmanship.
- C. No work shall progress until the Architect has reviewed mock-up panel(s). Panel(s) shall be revised as necessary to secure the Architect's acceptance and shall then become the standard of comparison for all related exterior wall work.
- D. Mock-up panel(s) shall not be destroyed or moved until the Work is complete and accepted by the Architect. Upon completion of construction, mock-ups shall be removed.

1.06 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

1.07 PROTECTION, HANDLING AND STORAGE

- A. Protect plastic insulation from exposure to sunlight, except as necessary for period of installation and concealment. Protect plastic insulation against ignition at all times. Do not deliver plastic insulation materials before installation time. Complete installation and concealment of plastic materials as quickly as possible.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Rigid Perimeter Insulation Board (at Foundations): Type 1 - Extruded polystyrene board.
- B. Insulation Over Metal Stud Framed Walls, Continuous: Type 2 - Polyisocyanurate insulation board.
- C. Batt Insulation (in steel framed ceiling structure): Batt insulation with no vapor retarder.
- D. Acoustic Insulation (in metal framed walls): Batt insulation.
- E. Safing Insulation: Fiber firestopping insulation.

2.02 FOAM BOARD INSULATION MATERIALS

- A. Type 1 - Extruded Polystyrene Board Insulation: ASTM C 578, Type IV; Extruded polystyrene board with either natural skin or cut cell surfaces; with the following characteristics:
 - 1. Flame Spread Index: 5 or less, when tested in accordance with ASTM E 84.
 - 2. Smoke Developed Index: 145 or less, when tested in accordance with ASTM E 84.
 - 3. Board Size: 24 x 96 inch.
 - 4. Board Thickness: 2 inches and as indicated on the Drawings.
 - 5. Board Edges: Square.
 - 6. Thermal Resistance at 75 degrees F: 5.0 per inch.
 - 7. Compressive Resistance: 25 psi.
 - 8. Water Absorption, maximum: 0.1 percent, volume.
 - 9. Products for Rigid Perimeter Insulation:
 - a. Styrofoam or Styrofoam Scoreboard by Dow Chemical Co.
 - b. Foamular 250 by Owens Corning Corp.
- B. Type 2 - Polyisocyanurate Insulation Board: Rigid cellular foam, complying with ASTM C 1289; Type II, Class 2, polymer bonded glass fiber mat both faces.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.

3. Complies with fire-resistance requirements shown on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
 - a. See the attached Basis of Design Manufacturer Wall Assembly Guide Summary attached to the end of this section for reference.
4. Compressive Strength: 20 psi.
5. Board Size: 48 x 96 inch.
6. Board Thickness:
 - a. Wall Cavity: 3 inches.
 - b. Miscellaneous Details: As indicated on the Drawings.
7. Long-Term Thermal Resistance: Minimum R-5.6 per inch.
8. Board Edges: Square.
9. Product: (Basis of Design for an approved NFPA 285 system)
 - a. Xci CG by Hunter Panels LLC.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 BATT INSULATION MATERIALS

- A. Acoustic Batt Insulation: ASTM C665; flexible preformed batt or blanket, friction fit; minimum 25% recycled content.
 1. Flame Spread Index, ASTM E84: 25 or less.
 2. Smoke Developed Index, ASTM E84: 450 or less.
 3. Formaldehyde Content: Zero.
 4. Thickness for acoustic insulation: Depth of metal stud cavity unless otherwise indicated on the Drawings.
 5. Facing for acoustic: Unfaced.
 6. Product for acoustic insulation:
 - a. Sound Shield Free by Johns Manville.
 - b. EcoBatt by Knauf.
 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Thermal Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
 1. Fire Resistance, ASTM E84 Unfaced: Flame spread index 0; Smoke developed index 0.
 2. Thermal Resistance: R of 4 per inch.
 3. Thickness for thermal insulation: Depth of metal stud cavity unless otherwise indicated on the Drawings.
 - a. Application: Where indicated per the Drawings.
 4. Thermal Resistance: One layer R14 and one layer R24 for a total R value of 38.
 - a. Application(s): Garage Level Ceiling Areas and other locations as indicated per the Drawings.
 - b. Stagger joints both horizontally and vertically for multiple insulation layers.
 5. Manufacturers:
 - a. Thermafiber, Inc.
 - b. ROXUL, Inc; ComfortBatt
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Fiber Firestopping Insulation (Safing Insulation): ASTM C 665 Type 1, unfaced, high-melt mineral fiber batt and have the following properties:
 1. Thickness: 2 inch minimum thickness, and as required by tested assemblies.
 2. Density, ASTM D1622: 4 pcf.
 3. Flame Spread, ASTM E 84: 15
 4. Smoke Developed ASTM E 84: 0
 5. Max. Water Absorption, ASTM C 272: 0.1% by volume
 6. Accessories: Manufacturer's "Z" impaling clips as required.
 7. Products:
 - a. Thermafiber by USG.
 - b. Safing Insulation / MW by Owens Corning Insulation

- c. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 FOAM INSULATION

- A. Foam Insulation Sealant: Expanding, low VOC, HCFC-free, urethane foam sealant
 - 1. Products:
 - a. Pur Fil IG 750 Foam by Todol Products, Inc.
 - b. Great-stuff Pro by Dow Chemical Co.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORIES

- A. Sheet Vapor Retarder:
 - 1. Application(s): Below all slab on grade areas and as indicated per the Drawings.
 - 2. Where concealed and in substantial contact with finishes: 3-ply laminate, combining 2 layers of high-density polyethylene and 1 high-strength non-woven cord grid. Class C, ASTM E 1745.
 - 3. Puncture Propagation Tear: 28 lb, ASTM D 2582.
 - 4. Puncture Strength: 24 lb, ASTM D 4833.
 - 5. Permeance (Perm): 0.038 grains/hr-ft²-in, ASTM E 96.
 - 6. Products:
 - a. Griffolyn Type 65-FR by Reef Industries Inc.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Tape: Ensure accessories are from the same manufacturer as reinforced vapor retarders.
 - 1. Mastic Tape: Black, double sided, asphaltic, pressure-sensitive, mastic tape.
 - 2. 3 inch Seam Shear: 35 lbs.
 - 3. Thickness: 35 mils.
 - 4. Product: Griffolyn Fab Tape by Reef Industries Inc
- C. Fasteners and Adhesive: As recommended by the insulation manufactures and as approved by Factory Mutual, material manufacturers, and related codes where applicable. In general, adhesives and fasteners shall be "Construction Grade", corrosion resistant stainless steel or galvanized, as suitable for damp locations.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation and adhesive.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT FOUNDATION PERIMETER

- A. Apply adhesive to back of boards:
 - 1. Three continuous beads per board length.
- B. Install boards horizontally on foundation perimeter.
 - 1. Place boards to maximize adhesive contact.
 - 2. Install in running bond pattern.
 - 3. Butt edges and ends tightly to adjacent boards and to protrusions.
- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT EXTERIOR FURRED WALLS

- A. Apply adhesive to back of boards:
 - 1. Three continuous beads per board length.
- B. Install boards horizontally on the interior surface of concrete and masonry walls, as detailed.
 - 1. Place boards to maximize adhesive contact.
 - 2. Install in running bond pattern.

3. Butt edges and ends tightly to adjacent boards and to protrusions.
 4. Fit between steel zee clips, or as otherwise detailed.
- C. Extend boards over expansion joints, unbonded to wall on one side of joint.
- D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BOARD INSTALLATION AT CAVITY WALLS

- A. Install boards to fit snugly between wall ties and secure with thermal clip.
- B. Install boards horizontally on walls.
1. Install in running bond pattern.
 2. Butt edges and ends tightly to adjacent boards and to protrusions.
 3. Where required, use supplemental impaling fasteners with locking discs to secure insulation boards.
- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- D. All joints and gaps between insulation board shall be sealed with foam sealant compatible with the insulation board.

3.05 BOARD INSTALLATION UNDER CONCRETE SLABS

- A. Exterior wall perimeters shall have horizontal rigid insulation installed for a width of four (4) feet.
- B. Place insulation after base for slab has been compacted.
- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane. Stagger end joints.
- D. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.
- E. Note that vapor retarder specified here-in shall be furnished and installed as part of the Work of Section 03 00 00 - Cast-in-Place Concrete.

3.06 THERMAL AND ACOUSTIC BATT INSTALLATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install thermal insulation in exterior wall, roof, and ceiling spaces without gaps or voids. Do not compress insulation.
- C. Install acoustic insulation between studs and other materials. Friction fit to prevent sliding and sagging. Provide additional clips and fasteners as required.
- D. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- E. Fit insulation tightly in cavities and tightly behind mechanical and electrical services within the plane of the insulation.
- F. All batt insulation shall be isolated from occupiable building spaces by a sealed fire retardant vapor barrier, gypsum board or other approved finish. Exposed insulation shall not be permitted in habitable areas.

3.07 SAFING INSULATION

- A. Install insulation as part of firestopping and smoke sealing in all floor/ceiling assembly penetrations, as required by fire sealant manufacturer's tested assemblies, as indicated on the Drawings, or as otherwise required for uninterrupted fire and smoke protection. Coordinate installation with Firestops and Smokestops specified in Section 07 84 00 - Firestopping. NOTE: Unless specifically noted otherwise, firesafing insulation shall serve as back-up firestopping at penetrations. The primary firestopping shall be firestops as specified in Section 07 84 00 - Firestopping.
- B. Insulation shall be cut to fit snugly and neatly with the smooth face toward the visible side. Where small pieces are used to close holes or gaps, they shall be neatly packed into the opening to be filled, out of view. Provide concealed mechanical fasteners as required.

3.08 INSULATION AT SPANDREL GLASS INSTALLATION

- A. In general, for fire containment at perimeter curtainwall systems, firesafing insulation shall be mechanically attached to curtainwall mullions and transoms using impaling pins, screws or other positive mechanical attachment as required. Install in strict accordance with the manufacturer's recommendations. Firesafing insulation shall be compression fit into the floor line void between floor structure and curtainwall firesafing, supported with "Z" clips.
- B. Install a light gage steel angle or channel continuously behind the insulation and attached to the vertical mullions at the floor firesafing line to prevent bowing of the curtainwall insulation due to compression of the firesafing insulation at the floor line. Exposed curtainwall mullions shall be protected with firesafing mullion covers.
- C. Install insulation between aluminum framing members and other surfaces with insulation fitting snugly to prevent settling. All voids and gaps shall be completely filled.
- D. Firestopping shall be installed on the floor line firesafing insulation. Installations shall be in accordance with UL tested assemblies.

3.09 VAPOR RETARDER INSTALLATION

- A. Vapor retarders shall be installed to provide continuous coverage on the warm-side insulation surface, with as few penetrations as necessary.
- B. All joints shall be lapped six (6) inches minimum and shall be sealed and/or taped as recommended by the manufacturer. Seal tightly around all terminations, obstructions, and penetrations.

3.10 FOAM INSULATION INSTALLATION

- A. Install foam insulation continuously to completely fill all gaps and voids at insulation boards, at voids in deck flutes, at voids around window and door frames, and at locations as indicated on the Drawings.
- B. Install foam insulation following manufacturer's instructions and recommendations. Exercise caution not to overfill voids. Insulation shall be permitted to expand without causing the deflection of adjacent materials. Use non-expanding foam at perimeters of doors and windows.

END OF SECTION



HUNTER
CONTINUOUS INSULATION

Hunter Xci CG – Wall Assembly Guide SUMMARY

Per Chapter 26 of the International Building Code, the wall assembly shall be tested in accordance with and comply with the acceptance criteria of NFPA 285. The listed assemblies in this document have met that criteria.

I BASE WALL SYSTEM	Steel Stud — 1 layer 5/8" thick Type X or 1/2" thick Type C Gypsum wallboard on interior, installed over steel studs: minimum 3 5/8" depth, minimum 22 gauge at a maximum of 24 inch o.c. with lateral bracing every 4 ft vertically.	
II APPROVED EXTERIOR FINISH	Masonry	Brick veneer anchors, standard types, installed maximum 24 inches o.c. vertically on each stud. Maximum 2 inch air gap between exterior insulation and brick. Standard nominal 4 inch thick or greater, clay brick.
	Stucco	Minimum 3/4" thick, Exterior Cement Plaster and Lath
	Limestone or Natural Stone	Minimum 2" thick, Limestone or Natural Stone Veneer or minimum 1 1/2" thick Cast Artificial Stone Veneer. Any standard installation technique can be used.
	Terra Cotta Cladding	Use any Terra Cotta Cladding System in which Terra Cotta is minimum 1 1/4". Any standard installation technique can be used.
	MCM System	Use any Metal Composite Material system that has been successfully tested by the panel manufacturer via the NFPA 285 test method. Any standard installation technique can be used.
	Metal Exterior	Metal Exterior wall coverings such as Steel, Aluminum, Copper, etc. Any standard installation technique can be used.
	Fiber Cement	Fiber Cement Board siding. Any standard installation technique can be used.
	Stone Aluminum	Stone Aluminum Honeycomb Composite Panels that have been successfully tested by the panel manufacturer via the NFPA 285 test method. Any standard installation technique can be used.
Hunter Panels is currently conducting additional NFPA Assembly tests. Please go to www.hunterxci.com for the latest updated literature.		
III MATERIAL OPTIONS	3.5" max thickness of Hunter Xci CG , 4x8 panels or cut to size	
IV FLOORLINE FIRESTOPPING	4 lb/cu ft mineral wool (e.g. Thermafiber) in each stud cavity and at each floor line, attached with Z Clips or equivalent	
V STUD CAVITY	Non Combustible Insulation or None	
VI EXTERIOR SHEATHING	1/2" or 5/8" thick exterior type gypsum sheathing	
VII WEATHER RESISTIVE MEMBRANE APPLIED TO GYPSUM	Carlisle: Barritech VP, Barritech NP, CCW 705 FR-A, CCW 705 VP Henry: Air Bloc 32MR Prosoco R-Guard: MVP, CAT-5, VB, Spray Wrap VaproShield: WrapShield SA DuPont™ Tyvek® Fluid Applied WB StoCorp: StoGuard™ VaporSeal™, EmeraldCoat, Gold Coat W.R. Grace: Perm-A-Barrier VPS Or None	
VIII WEATHER RESISTIVE MEMBRANE APPLIED TO EXTERIOR INSULATION	VaproShield: WrapShield SA DuPont™ Tyvek® Fluid Applied WB Carlisle: Barritech VP, Barritech NP, CCW 705 FR-A, CCW 705 VP Or None	

The location and number of WRB's in the wall assembly are determined by the architect.

0314

SECTION 07 25 00
WEATHER BARRIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Weather Barrier System: Membrane, transition membrane and wall flashings for a complete system to perform as a combined continuous air barrier and vapor retarder.
- B. Exterior wall assemblies incorporating the product and accessories shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.

1.02 RELATED REQUIREMENTS

- A. Section 04 20 00 - Unit Masonry: Drip flashing and coordination of membrane thru-wall flashing.
- B. Section 07 21 00 - Thermal Insulation: Rigid cavity wall insulation board.
- C. Section 07 53 00 - Elastomeric Membrane Roofing: Vapor retarder installed as part of roofing system.
- D. Section 07 54 00 - Thermoplastic Membrane Roofing: Vapor retarder installed as part of roofing system.
- E. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashings installed in conjunction with weather barriers.
- F. Section 07 90 05 - Joint Sealers: Sealant materials and installation techniques.
- G. Section 08 44 13 - Glazed Aluminum Curtain Walls: Perimeter transition flashing for weather barrier system.

1.03 DEFINITIONS

- A. Weather Barrier System: Assemblies that form a combined water-resistive barrier and vapor barrier.
- B. Air Barrier: Air-tight barrier made of material that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces. Note: For the purposes of this specification, vapor impermeable air barriers are classified as vapor retarders.
- C. Vapor Retarder: Air-tight barrier made of material that is relatively water vapor impermeable, to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.
 - 1. Water Vapor Permeance: For purposes of conversion, $57.2 \text{ ng}/(\text{Pa s sq m}) = 1 \text{ perm}$.
- D. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture-resistant, to the degree specified, intended to send water to outside of the wall assembly.

1.04 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- B. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials; 2013.
- C. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc.; 2013.
- D. ICC-ES AC212 - Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing; ICC Evaluation Service, Inc.; 2012.
- E. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on material characteristics, performance criteria, and limitations.

1. Manufacturer's list and description of wall assemblies incorporating specified product in compliance with NFPA 285.
- C. Shop Drawings: Provide drawings of special joint conditions, terminations, flashings, penetrations, window and door openings and treatment of substrate joints and cracks.
- D. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.
- E. Samples: Submit representative samples of sprayed coating, sheet seal, transition membrane, and membrane wall flashing.
- F. Certifications:
 1. Submit certification by weather barrier manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
 2. Submit weather barrier manufacturer's certification of compatibility of weather barrier with all materials in contact with it.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Weather barrier systems shall be manufactured and marketed by a firm with a minimum of 20 years experience in the production and sales of waterproofing. Manufacturers proposed for use, but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.
- B. Installer: The installer shall demonstrate qualifications to perform the work of this Section by submitting the following:
 1. Written confirmation or certification from the Waterproofing Manufacturer that the installer has been trained and is recognized by the manufacturer as suitable for the execution of the work.
 2. List of at least three projects contracted within the past five years of similar scope and complexity to this Project carried out by the firm and site supervisor.
 3. Installer must show evidence of adequate equipment and trained field personnel to successfully complete the project in a timely manner.
- C. Materials Source Limitations: For each type of material required for the work of this Section, provide primary materials and weather barrier accessories that are the products of one manufacturer.

1.07 PERFORMANCE REQUIREMENTS

- A. General: Weather barrier shall be capable of performing as a continuous vapor barrier and as water resistive barrier, flashed to discharge to the exterior incidental condensation or water penetration. Weather barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to embedded flashing, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Fire Testing: Weather barrier system as a component of a wall assembly shall have been tested and passed NFPA 285. Refer to Section 07 21 00 Thermal Insulation for basis of design tested wall assembly.

1.08 MOCK-UPS AND SAMPLE INSTALLATIONS

- A. Mock-Up(s): Provide weather barrier system in exterior wall mock(s) as specified in Section 04 20 00 Unit Masonry.
 1. Mock-up panel(s) shall demonstrate actual wall construction, detailing and workmanship.
 2. No work shall progress until the Architect has reviewed the mock-up panel(s). Panel(s) shall be revised as necessary to secure the Architect's acceptance and shall then become the standard of comparison for all related exterior wall work.

3. Mock-up panel(s) shall not be destroyed or moved until the Work is complete and accepted by the Architect. Upon completion of construction, mock-up(s) panels shall be removed.
- B. Sample Installation: Prior to commencement of the complete installation of the weather barrier system, a sample installation shall be provided to verify details, tie-ins and to demonstrate the required quality of materials, installation and workmanship.
1. The sample installation shall be applied to a constructed exterior wall section, 8 feet long and 8 feet wide, at a location to be determined by the Architect, incorporating brick shelf, window and door frame head, jamb and sill flashing and masonry ties.
 2. No work shall progress until the Architect has reviewed the sample installation. Sample installation shall be revised as necessary to secure the Architect's acceptance.

1.09 PRE-INSTALLATION MEETING

- A. Pre-Installation Conference: A pre-installation conference shall be held one (1) week prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include but not be limited to the following:
1. Review of submittals.
 2. Review of surface preparation, minimum curing period and installation procedures.
 3. Review of special details and flashings.
 4. Sequence of construction, responsibilities and schedule for subsequent operations.
 5. Review of mock-up requirements.
 6. Review of inspection, testing, protection and repair procedures.
- B. Manufacturer's Representative: Make arrangements necessary to have a trained employee of the manufacturer on-site periodically during membrane work to review installation procedures.

1.10 DELIVERY, STORAGE AND PROTECTION

- A. Materials shall be delivered in manufacturer's original sealed containers clearly labeled with manufacturer's name, product identification, safety information, net weight, and expiration date.
- B. Materials shall be stored in a safe manner within temperature limits specified by the materials manufacturer.
- C. Avoid spillage. Immediately notify Owner and Architect if spillage occurs and start clean up procedures. Clean spills and leave area as it was prior to spill.
- D. Observe safety and environmental measures indicated in manufacturer's MSDS, and mandated by federal, state and local regulations.

1.11 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.

1.12 WARRANTY

- A. Provide the manufacturer's five year materials warranty, covering the primary weather barrier, accessory sealant and membrane materials against failure to cure, or achieve airtight and watertight seal, or to adhere.

PART 2 PRODUCTS

2.01 WEATHER BARRIER MATERIALS

- A. Weather Barrier Fluid-Applied Coating: Fire-resistant, liquid water drainage plane, air and vapor barrier system.
1. Wet Film Thickness: 70 to 80 mils.
 2. Dry Film Thickness: 38 to 43 mils.
 3. Application Temperature: 40 degrees F. minimum.
 4. Color: Un-cured medium blue; cured dark blue.

5. VOC Content: <10 g/L
6. Air Permeance, ASTM E2178: 0.0010 L/s sq m at 75 Pa.
7. Water Vapor Permeance, ASTM E96A: 0.05 perms
8. Wall Assembly Burn Test, NFPA 285: Passes as part of various wall assemblies with up to 3" of polyiso or XPS insulation.
9. Basis of Design: Barritech NP by Carlisle Coatings & Waterproofing, Inc.
10. Substitutions: See Section 01 60 00 - Product Requirements.

B. Joint Filler: As recommended by coating manufacturer and suitable to the substrate.

2.02 SEALANTS

- A. Sealants: As recommended by the weather barrier system manufacturer for each application. Sealants shall have been tested for chemical and adhesive properties in relation to adjacent surface materials and approved in writing by the weather barrier system manufacturer.
- B. Sealant Backers: As specified in Section 07 90 05.
- C. Primers, Cleaners, and Other Sealant Materials: As recommended by sealant manufacturer, appropriate to application, and compatible with adjacent materials.

2.03 ADHESIVES

- A. Contact Adhesive: As recommended by the coating manufacturer.
- B. Termination Mastic: As recommended by the coating manufacturer.

2.04 ACCESSORIES

- A. Membrane Flashing: 40 mil self-adhering sheet fire-resistive flashing / membrane.
 1. Product: 705FP by Carlisle Coatings and Waterproofing.
- B. Detail Flashing: Foil-faced butyl or foil-faced rubberized asphalt flashing; 30 mils thickness, approved with weather barrier membrane in NFPA 285 wall assemblies.
 1. Product: AlumaGrip-701 by Carlisle Coatings & Waterproofing, Inc.
- C. Surface Conditioner / Primer: Required, as recommended by coating manufacturer and suitable to the substrate.
- D. Thinners and Cleaners: As recommended by material manufacturer.
- E. Drip Flashing: Membrane flashing termination at exterior of masonry veneer. See 04 20 00 - Unit Masonry.
- F. Perimeter Transition Flashing System: Factory-fabricated silicone transition system from weather barrier membrane to aluminum door, window and louver framing. See Section 08 44 13 - Glazed Aluminum Curtain Walls.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and conditions are ready to accept the work of this Section. Notify the Contractor, in writing, of circumstances detrimental to the proper completion of the Work. Do not proceed with work until unsatisfactory conditions are corrected.
- B. Aluminum window, curtainwall and louver framing perimeters shall receive perimeter transition flashing system as a part of the work of those Sections. Notify the Contractor if perimeter transition flashing system is unsatisfactory for the installation of weather barrier tie-ins.

3.02 PREPARATION

- A. Remove dust, dirt, oils, loose or foreign matter which might impair adhesion of materials.
- B. Masonry walls shall have mortar joints struck flush. All voids and holes, particularly in the mortar joints, shall be filled with lean mortar mix, non-shrink grout or parge coat.
- C. Exterior sheathing substrates shall be sufficiently stabilized with corners and edges fastened with appropriate fasteners. Pre-treat all board joints with 2 to 3 inch wide, reinforced self-

adhesive tape or fiberglass mesh style wallboard tape. Gaps greater than 1/4 inch shall be filled with mastic or sealant, fully cured before application of tape and sprayed coating.

- D. Prime masonry substrate surfaces to receive adhesives and self-adhering membrane in accordance with manufacturer's instructions.

3.03 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Install continuous weather barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.
- C. Apply sealants and adhesives within recommended application temperature ranges. Consult manufacturer if temperature is out of this range.
- D. Fluid-Applied Coatings:
 - 1. Prepare substrate in manner recommended by coating manufacturer; treat joints in substrate and between dissimilar materials as recommended by manufacturer.
 - 2. Install sprayed coating over entire exterior surface; seal to adjacent construction with compatible sheet.
 - a. Spray with overlapping passes for a continuous uniform film thickness.
 - b. Carry coating into any openings a minimum of 3 inches.
 - c. Seal all penetrations as work progresses.
 - 3. Where exterior masonry veneer is to be installed, install masonry anchors before installing weather barrier over masonry; seal around anchors air tight.
 - 4. Use flashing to seal to adjacent construction and to bridge joints as recommended by system manufacturer. Provide backer rods to support membrane at joints to be bridged where required.
- E. Openings and Penetrations in Weather Barrier:
 - 1. Transition Membrane: After allowing the sprayed coating to cure to tack-free, apply transition membrane to overlap perimeter transition flashing system installed by others at door and window framing perimeters, roof and floor intersections, and changes in substrate. Use pre-cut, easily handled lengths for each location.
 - a. Remove release paper and position membrane flashing carefully before placing it against the surface. When properly positioned, place against surface by pressing firmly into place by hand roller. Overlap adjacent pieces 2 inches, or manufacturer's recommended amount and roll all seams with a hand roller. Seal to edge of flashing with termination mastic.
 - 2. Membrane Flashing: Locate at heads of openings, items that bridge the cavity and other locations as indicated on the Drawings. Fully adhere flashing to substrate to prevent water from migrating under the flashing and seal top edge with termination mastic.
 - a. Remove release paper and position membrane flashing carefully before placing it against the surface. When properly positioned, place against surface by pressing firmly into place by hand roller. Overlap adjacent pieces 2 inches and roll all seams with a hand roller. Seal to edge of flashing with termination mastic.
 - b. Trim bottom edge 1/2 inch back from exposed face of the exterior wall. Flashing shall not be permanently exposed to sunlight. Flashing shall be adhered to top surface of metal flashing drip edge that shall project beyond face of exterior wall.
 - c. At heads, sills and all flashing terminations, turn up ends a minimum of 2 inches and make careful folds to form an end dam, with the seams sealed.
 - d. Do NOT allow the rubberized asphalt surface of the flashing membrane to come in contact with polysulfide sealants, creosote, uncured coat tar products or EPDM.
 - 3. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto weather barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
 - 4. At openings to be filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with at least 4 inches wide; do not seal sill flange.

5. At openings to be filled with non-flanged frames, seal weather barrier to all sides of opening framing, using flashing at least 9 inches wide, covering entire depth of framing.
6. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
7. Service and Other Penetrations: Form flashing around penetrating item and seal to weather barrier surface.
8. Treat construction joints and install flashing as recommended by manufacturer.

3.04 WASTE MANAGEMENT AND DISPOSAL

- A. Separate and recycle waste materials in accordance with the waste disposal plan. See Section 01 74 19. Place materials defined as hazardous or toxic waste in designated containers. Ensure emptied containers are stored safely for disposal.

3.05 FIELD QUALITY CONTROL

- A. Do not cover installed weather barriers until required inspections have been completed.

3.06 PROTECTION AND CLEANING

- A. Do not leave materials exposed to weather longer than recommended by manufacturer.
- B. Remove any masking materials after installation. Clean any stains on materials that would be exposed in the completed work using procedures as recommended by the manufacturer.
- C. Protect membranes to avoid damage from other trades, and construction materials during subsequent operations.
- D. For cavity insulation boards, bonding of the insulation may be achieved if the insulation products are installed when the membrane is tacky.
- E. Schedule work to ensure that the weather barrier is covered as soon as possible after installation. Protect the installation from damage during subsequent operations. If the installation cannot be covered within 30 days after installation, apply temporary UV protection such as dark plastic sheet or tarpaulins.

END OF SECTION

SECTION 07 42 13
METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured metal panels for roof top equipment screen walls, with accessory components.
- B. Manufactured metal panels for exterior soffits and ceiling areas, with accessory components.
- C. Secondary framing systems and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 05 40 00 - Cold-Formed Metal Framing: Wall panel substrate.
- B. Section 07 21 00 - Thermal Insulation.
- C. Section 07 25 00 - Weather Barriers: Weather barrier under wall panels.
- D. Section 07 92 00 - Joint Sealants: Sealing joints between metal wall panel system and adjacent construction.

1.03 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate dimensions, layout, joints, construction details, methods of anchorage.
- C. Samples: Submit two samples of wall panel and soffit panel, 8 inch by 8 inch in size illustrating finish color, sheen, and texture.
- D. Design Data: Submit structural calculations stamped by design engineer, for Architect's information and project record.

1.05 QUALITY ASSURANCE

- A. Design Engineer's Qualifications: Design structural supports and anchorages under direct supervision of a Structural Engineer experienced in design of this type of Work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum fifteen years of documented experience.
- C. Installer Qualifications: Company specializing in installing the products specified in this Section with minimum five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store prefinished material off ground and protected from weather. Prevent twisting, bending, or abrasion, and provide ventilation to stored materials. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials that may cause discoloration or staining of products.

1.07 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion for degradation of panel finish, including color fading caused by exposure to weather.

PART 2 PRODUCTS

2.01 MANUFACTURED METAL PANELS

- A. Metal Wall Pane I System: Factory fabricated prefinished metal panel system, site assembled.
 - 1. Provide exterior panels, soffit panels, and accessories.
 - 2. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall. See Structural Drawings for design wind speed. In accordance with applicable codes.
 - a. Provide structural design by or under direct supervision of a Structural Engineer licensed in the State in which the Project is located.
 - 3. Maximum Allowable Deflection of Panel: 1/180 of span.
 - 4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
 - 5. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 - 6. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
 - 7. Corners: Factory-fabricated in one continuous piece with minimum 18 inch returns.
 - 8. Exterior Finish: Panel manufacturer's standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.
 - 9. Exterior Panel Back Coating: Panel manufacturer's standard polyester wash coat.
- B. Metal Wall Panels:
 - 1. Product (Basis of Design): Belvedere Rib (BWR360) by ATAS.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
 - 3. Profile: Ribbed.
 - 4. Texture: Smooth.
 - 5. Material: Precoated aluminum sheet, 18 gage, 0.0403 inch minimum thickness.
 - 6. Panel Width: 36 inches.
 - 7. Corrugations 7.2" on center and 1.5" projection.
 - 8. Color: 13 - Dove Grey.
- C. Soffit Panels:
 - 1. Product (Basis of Design): Opaline OPW (OPW045) by ATAS.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
 - 3. Texture: Smooth.
 - 4. Side Seams: Double-interlocked with reveal, sealed with continuous gaskets.
 - 5. Panel Width: 4.5 inches.
 - 6. Panel Height: 3/4 inches.
 - 7. Material: Precoated aluminum sheet, 20 gage, 0.032 inch minimum thickness.
 - 8. Color: 06 - Sandstone.
- D. Metal Framing Members: Include all sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
 - 1. Provide material strength, dimensions, configuration as required to meet the applied loads applied and in compliance with applicable building code.
 - 2. Sheet Steel Components: ASTM A653/A653M galvanized to G90/Z275 or zinc-iron alloy-coated to A60/ZF180; or ASTM A792/A792M aluminum-zinc coated to AZ60/AZM180.
 - 3. Stainless Steel Sheet Components: ASTM A480/A480M.
- E. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.
- F. Expansion Joints: Same material, thickness and finish as exterior sheets; ___ gage, ___ inch thick; manufacturer's standard brake formed type, of profile to suit system.

- G. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.
- H. Anchors: Stainless steel.

2.02 MATERIALS

- A. Precoated Aluminum Sheet: ASTM B209 3105 alloy, smooth surface texture; thickness shall match existing; continuous-coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.03 ACCESSORIES

- A. Trims and Caps: Manufacturer's standard type suitable for use with system, permanently resilient.
- B. Sealants: Manufacturer's standard type suitable for use with installation of system; non-staining.
- C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized. Fastener cap same color as exterior panel.
- D. Field Touch-up Paint: As recommended by panel manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect all panels.
- B. Verify that building framing members are ready to receive panels.
- C. Verify that weather barrier has been installed over substrate completely and correctly.

3.02 PREPARATION

- A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane. Space at intervals indicated.

3.03 INSTALLATION

- A. Install panels on walls and soffits in accordance with manufacturer's instructions.
- B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint. Allow to dry prior to installation.
- C. Fasten panels to structural supports; aligned, level, and plumb.
- D. Locate joints over supports. Lap panel ends minimum 2 inches.
- E. Provide expansion joints where indicated.
- F. Use concealed fasteners unless otherwise approved by Architect.

3.04 TOLERANCES

- A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.
- B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.05 CLEANING

- A. Remove site cuttings from finish surfaces.
- B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

END OF SECTION

SECTION 07 42 64
METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Exterior cladding consisting of formed metal composite material (MCM) sheet, secondary supports, and anchors to structure, attached to solid backup.
- B. Matching flashing and trim.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Installation of anchors.
- B. Section 04 20 00 - Unit Masonry: Installation of anchors.
- C. Section 05 40 00 - Cold-Formed Metal Framing: Panel support framing.
- D. Section 07 25 00 - Weather Barriers: Weather barrier behind rainscreen wall system.
- E. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashing components integrated with this wall system.
- F. Section 07 92 00 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- D. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2015.
- E. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2014a.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.
- G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
- H. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2010.
- I. ASTM D523 - Standard Test Method for Specular Gloss; 2008.
- J. ASTM D1781 - Standard Test Method for Climbing Drum Peel for Adhesives; 1998 (Reapproved 2012).
- K. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2013a.
- L. ASTM D2244 - Standard Practice for Calculation of Color Differences from Instrumentally Measured Color Coordinates; 2011.
- M. ASTM D4145 - Standard Test Method for Coating Flexibility of Prepainted Sheet; 2010.
- N. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films; 2007.
- O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.

- P. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).
- Q. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors By Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).
- R. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012.

1.04 QUALITY ASSURANCE

- A. Design Engineer's Qualifications: Design structural supports and anchorages under direct supervision of a Structural Engineer experienced in design of this type of Work and licensed in the State in which the Project is located.
- B. Testing Agency Qualifications: Independent agency experienced in testing assemblies of the type required for this project and having the necessary facilities for full-size mock-up testing of the type specified.

1.05 WARRANTY

- A. MCM Sheet Manufacturer's Finish Warranty: Provide manufacturer's written warranty stating that the finish will perform as follows for minimum of 5 years:
 - 1. Chalking: No more than that represented by a No.8 rating based on ASTM D4214.
 - 2. Color Retention: No fading or color change in excess of 5 Hunter color difference units, calculated in accordance with ASTM D2244.
 - 3. Gloss Retention: Minimum of 30 percent gloss retention, when tested in accordance with ASTM D523.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Composite Material Sheet Manufacturers:
 - 1. Basis of Design: SterraCore (MAU999) by ATAS.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 WALL PANEL SYSTEM

- A. Wall Panel System: Metal panels, fasteners, and anchors designed to be supported by framing or other substrate provided by others; provide installed panel system capable of maintaining specified performance without defects, damage or failure.
 - 1. Provide structural design by or under direct supervision of a Structural Engineer licensed in the State in which the Project is located.
 - 2. Provide panel jointing and weatherseal using reveal joints and gaskets but no sealant.
 - 3. Anchor panels to supporting framing without exposed fasteners.
- B. Performance Requirements:
 - 1. Thermal Movement: Provide for free and noiseless vertical and horizontal thermal movement due to expansion and contraction under material temperature range of minus 20 degrees F to 180 degrees F without buckling, opening of joints, undue stress on fasteners, or other detrimental effects; allow for ambient temperature at time of fabrication, assembly, and erection procedures.
 - 2. Structural Performance: Panels and secondary support systems shall be designed and sized to withstand all dead loads and wind loads caused by positive and negative wind pressure acting normal to plane of panel in accordance with structural criteria listed on the Structural Drawings, 2009 IBC and FM.
 - a. Factory Mutual Wind Requirements: Wind Force Outward: 22.6 psf for field zone 4; 27.8 psf for corners zone 5. Wind Force Inward: 20.8 psf for field and corners.
 - b. Comply with ASCE 7, importance factor 1.15.

- c. FM Standards Design Wind Speed: 100 mph, 3 second peak gust with Ground Roughness Exposure B.
 - d. Structural performance of wall panels shall be derived from ASTM E72 Chamber Method with a deflection limit of 1/180. There shall be no evidence of delamination of wall panels after two million cycles of positive and negative L/180 deflection.
 - e. Maximum Allowable Deflection of Panel: 1/180.
 3. Air Infiltration: 0.06 cfm/sq ft of wall area, maximum, when tested at 1.57 psf in accordance with ASTM E283.
 4. Water Penetration: No water penetration under static pressure when tested in accordance with ASTM E331 at a differential of 10 percent of inward acting design load, 6.24 psf minimum, after 15 minutes.
 - a. Water penetration is defined as the appearance of uncontrolled water on the interior face of the wall.
 - b. Design to drain leakage and condensation to the exterior face of the wall.
 5. Fire Performance: Tested in accordance with, and complying with the acceptance criteria of, NFPA 285; testing performed for previous project is acceptable provided tested system was truly equivalent.
 6. Fabricate the panel system so that no restraints can be placed on panels that might result in compressive skin stresses. The installation detailing shall be such that the panels remain flat regardless of temperature change and at all times remain air and water tight.
- C. Panels: One inch deep pans formed of metal composite material sheet by routing back edges of sheet, removing corners, and folding edges.
1. Reinforce corners with riveted aluminum angles.
 2. Provide concealed attachment to supporting structure by adhering attachment members to back of panel; attachment members may also function as stiffeners.
 3. Maintain maximum panel bow of 0.8 percent of panel dimension in width and length; provide stiffeners of sufficient size and strength to maintain panel flatness without showing local stresses or read-through on panel face.
 4. Secure members to back face of panels using structural silicone sealant approved by MCM sheet manufacturer.
 5. Metallic Finished Panels: Maintain consistent grain of MCM sheet; specifically, do not rotate sheet purely to avoid waste.
 6. Fabricate panels under controlled shop conditions.
 7. Where final dimensions cannot be established by field measurement before commencement of manufacturing, make allowance for field adjustments without requiring field fabrication of panels.
 8. Fabricate as indicated on drawings and as recommended by MCM sheet manufacturer.
 - a. Make panel lines, breaks, curves and angles sharp and true.
 - b. Keep plane surfaces free from warp or buckle.
 - c. Keep panel surfaces free of scratches or marks caused during fabrication.
 9. Provide joint details providing a watertight and structurally sound wall panel system that allows no uncontrolled water penetration on inside face of panel system.
 10. For "dry" jointing, secure extrusions to returned pan edges with stainless steel rivets; provide means of concealed drainage with baffles and weeps for water that might accumulate in members of system.

2.03 MATERIALS

- A. Metal Composite Material (MCM) Sheet: Two sheets of aluminum sandwiching a solid core of extruded thermoplastic material formed in a continuous process with no glues or adhesives between dissimilar materials; core material free of voids and spaces; no foamed insulation material content.
1. Overall Sheet Thickness: 3 mm, minimum.
 2. Face Sheet Thickness: 0.019 inches, minimum.
 3. Alloy: Manufacturer's standard, selected for best appearance and finish durability.

4. Bond and Peel Strength: No adhesive failure of the bond between the core and the skin nor cohesive failure of the core itself below 22.4 inch-pound/inch with no degradation in bond performance, when tested in accordance with ASTM D1781, simulating resistance to panel delamination, after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F.
 5. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 6. Flammability: Self-ignition temperature of 650 degrees F or greater, when tested in accordance with ASTM D1929.
 7. Factory Finish: One coat fluoropolymer resin coating, approved by the coating manufacturer for the length of warranty specified for the project, and applied by coil manufacturing facility that specializes in coil applied finishes.
 - a. Coating Flexibility: Pass ASTM D4145 minimum 1T-bend, at time of manufacturing.
 - b. Long-Term Performance: Not less than that specified under WARRANTY in PART 1.
 8. Color: 06 - Sandstone.
- B. Metal Framing Members: Include all sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
1. Provide material strength, dimensions, configuration as required to meet the applied loads applied and in compliance with applicable building code.
 2. Sheet Steel Components: ASTM A653/A653M galvanized to G90/Z275 or zinc-iron alloy-coated to A60/ZF180; or ASTM A792/A792M aluminum-zinc coated to AZ60/AZM180.
 3. Stainless Steel Sheet Components: ASTM A480/A480M.
- C. Flashing: Sheet aluminum; 0.040 inch thick, minimum; finish and color to match MCM sheet.
- D. Anchors, Clips and Accessories: Use one of the following:
1. Stainless steel complying with ASTM A276/A276M, ASTM A480/A480M, or ASTM A666.
 2. Steel complying with ASTM A36/A36M and hot-dipped galvanized to ASTM A153/A153M.
 3. Steel complying with ASTM A36/A36M and hot-dipped galvanized to ASTM A123/A123M Coating Grade 10.
- E. Fasteners:
1. Exposed fasteners: Stainless steel; permitted only where absolutely unavoidable and subject to prior approval of the Architect.
 2. Screws: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
 3. Bolts: Stainless steel.
 4. Fasteners for Flashing and Trim: Blind fasteners of high-strength aluminum or stainless steel.
- F. Joint Sealer: Clear silicone sealant approved by MCM sheet manufacturer.
- G. Provide panel system manufacturer's and installer's standard corrosion resistant accessories, including fasteners, clips, anchorage devices and attachments.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and interfaces with other work.
- B. Verify substrate on-site to determine that conditions are acceptable for product installation in accordance with manufacturers written instructions.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Notify Architect in writing of conditions detrimental to proper and timely completion of work. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect adjacent work areas and finish surfaces from damage during installation.
- B. Deliver anchorage items to be cast into concrete or built into masonry to appropriate installer(s) together with setting templates.

3.03 INSTALLATION

- A. Do not install products that are defective, including warped, bowed, dented, and broken members, and members with damaged finishes.
- B. Comply with instructions and recommendations of MCM sheet manufacturer and wall system manufacturer, as well as with approved shop drawings.
- C. Install wall system securely allowing for necessary thermal and structural movement; comply with wall system manufacturer's instructions for installation of concealed fasteners.
- D. Do not handle or tool products during erection in manner that damages finish, decreases strength, or results in visual imperfection or failure in performance. Return component parts that require alteration to shop for refabrication, if possible, or for replacement with new parts.
- E. Do not form panels in field unless required by wall system manufacturer and approved by the Architect; comply with MCM sheet manufacturer's instructions and recommendations for field forming.
- F. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape where needed to eliminate possibility of electrolytic action between metals.
- G. Install flashings as indicated on shop drawings At flashing butt joints, provide a lap strap under flashing and seal lapped surfaces with a full bed of non-hardening sealant.
- H. Install square, plumb, straight, and true, accurately fitted, with tight joints and intersections maintaining the following installation tolerances:
 - 1. Variation From Plane or Location: 1/2 inch in 30 feet of length and up to 3/4 inch in 300 feet, maximum.
 - 2. Deviation of Vertical Member From True Line: 0.1 inch in 25 feet run, maximum.
 - 3. Deviation of Horizontal Member From True Line: 0.1 inch in 25 feet run, maximum.
 - 4. Offset From True Alignment Between Two Adjacent Members Abutting End To End, In Line: 0.03 inch, maximum.
- I. Replace damaged products.

3.04 CLEANING

- A. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.
- B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.
- C. Remove temporary coverings and protection of adjacent work areas.
- D. Clean installed products in accordance with manufacturer's instructions.

3.05 PROTECTION

- A. Protect installed panel system from damage during construction.

END OF SECTION

SECTION 07 53 00
ELASTOMERIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Elastomeric roofing membrane, mechanically fastened conventional application.
- B. Insulation, flat and tapered.
- C. Vapor retarder.
- D. Membrane flashings.
- E. Roofing cant strips, stack boots, roofing expansion joints, and walkway pads.
- F. Metal flashings and fascia related to membrane roofing under the total system warranty are specified in Section 07 62 00 - Sheet Metal Flashing and Trim.
- G. Commencement of work by Contractor shall constitute acknowledgement by Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.02 RELATED REQUIREMENTS

- A. Section 05 31 00 - Steel Decking: Product requirements for acoustical insulation for deck flutes, for placement by this section.
- B. Section 06 10 54 - Wood Blocking and Curbing: Wood nailers and curbs.
- C. Section 07 62 00 - Sheet Metal Flashing and Trim: Metalwork fascias, copings, counterflashings, reglets,.
- D. Section 07 72 00 - Roof Accessories: Roof-mounted units; prefabricated curbs.
- E. Division 22 - Plumbing: Roof drains.
- F. Division 23 - HVAC: Mechanical equipment penetrating the roofing.

1.03 REFERENCE STANDARDS

- A. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2014.
- B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension; 2006a (Reapproved 2013).
- C. ASTM D570 - Standard Test Method for Water Absorption of Plastics; 1998 (Reapproved 2010).
- D. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers; 2000 (Reapproved 2012).
- E. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact; 2013.
- F. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane; 2012.
- G. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials; 2010.
- H. NRCA ML104 - The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of associated counterflashings installed under other Sections.

- B. Pre-installation Meeting: After the submission and review of roofing and flashing shop drawings, samples and printed data, convene a pre-installation meeting at least two weeks before starting installation. Review preparation and installation procedures, coordination and scheduling necessary for related work, determine access, staging and storage areas, establish working weather conditions, roofing protection provisions, considerations for safety of building occupants and other relevant issues.
1. The following personnel shall be present:
 - a. Contractor (Project Manager, Superintendent)
 - b. Roofing Sub-Contractor (Project Manager, Foreman)
 - c. Roofing and Flashing Materials Manufacturers
 - d. Architect, Project Manager and Owner's Representative
 2. Verify compatibility of all materials in contact with roofing, including but not limited to:
 - a. Treated lumber.
 - b. Sealants and adhesives.
 - c. Waterstop membrane.
 - d. Insulations and roofing boards.
 - e. Vapor Retarders.
 - f. Sheathing.
 - g. Walkway pads.
 - h. All other roofing materials.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
- C. Shop Drawings: Provide roofing details and roof layout plan.
1. Indicate joint or termination detail conditions, conditions of interface with other materials, and setting plan for tapered insulation.
 2. Indicate areas, slopes and thicknesses of tapered insulation on roof layout plan.
 3. Indicate roof mounted equipment, hatches, etc.
 4. Indicate thickness and dimensions of all parts, fastening and anchoring methods, details and locations of seams, joints, and provisions necessary for thermal expansion and contraction. Key in details on roof layout plan.
 5. Indicate details of roof flashing including jointing, expansion joint flashing, intersections, intersections with walls, transitions from cants to walls, transitions from curbs to gravel stops, and any other details required for a complete watertight installation. Key in details on roof layout plan.
- D. Samples:
1. Submit samples illustrating insulation, roofing membrane, metal flashing, fasteners and underlayments.
- E. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.
- F. Manufacturer's Certificate: Certify that all products, including insulation, underlayment and related fasteners are satisfactory for their intended applications..
1. Submit final shop drawings to the roofing manufacturer for review as required by warranty requirements.
- G. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, supplementary instructions given, and substrates are acceptable to receive roofing..
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum twenty years of documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this Section with minimum five years documented experience, and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
- B. Store products in weather protected environment, clear of ground and moisture.
- C. Protect foam insulation from direct exposure to sunlight.
- D. Materials being stored on a roof surface shall not overload the deck or structural assembly.
- E. Lids shall be secured on cans of stored materials and all emulsions, coatings, adhesives, solvents, sealants, foams, etc. shall be stored at temperatures as recommended by the manufacturers.

1.08 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane when ambient temperature does not meet manufacturer installation requirements.
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.09 WARRANTY

- A. See Section 01 78 10 - Warranties, for additional warranty requirements.
- B. Applicator/Contractor Warranty: The roofing subcontractor hereby guarantees that all roofing items not covered by the roofing manufacturer's total system warranty shall be free from defective materials and workmanship for a period of two (2) years from the date of Substantial Completion. Upon notification of any such defects within said guarantee period the roofing subcontractor shall promptly make all necessary repairs and replacements at no cost or expense to the Owner. This warranty shall be signed and countersigned by the installer (Roofer) and the Contractor.
- C. Manufacturer's System and Membrane Warranties: Upon completion of the membrane roofing system work, the roofing materials manufacturer shall furnish the Owner a "Total System" warranty insuring a watertight roof for a period of twenty (20) years. The warranty shall cover all repairs necessary over the twenty (20) year period up to the original cost of the original roofing contract. The membrane shall also be warranted not to prematurely deteriorate to the point of failure because of weathering for a period of twenty (20) years. Warranty shall include maximum peak gust wind speed coverage of up to 100 mph.
- D. Pro-rated System Warranties shall not be accepted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. EPDM Membrane Materials:
 - 1. Sure-Seal EPDM by Carlisle SynTec.
 - 2. JM EPDM by Johns Manville.
 - 3. Firestone Building Products Co.

4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Manufacturer as recommended by the roofing system manufacturer.
- C. Manufacturer of insulation, fasteners, polymeric components, edgings, cover boards and other accessories or components required to complete the specified system: Same manufacturer as roof membrane or accepted by the manufacturer as compatible.
- D. Manufacturer of Metal Roof Edging: Same manufacturer as roof membrane.
 1. Metal roof edging products by other manufacturers are not acceptable.
 2. Field- or shop-fabricated metal roof edgings are not acceptable.

2.02 ROOFINGSYSTEM DESCRIPTION

- A. Roofing System: Scrim Reinforced Ethylene Propylene Diene Monomer membrane.
 1. Membrane Attachment: Mechanically fastened.
 2. Comply with applicable local building code requirements.
 3. Provide assembly having Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.
 4. Provide assembly complying with Factory Mutual Corporation (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.
- B. Roofing System - Type 1: Listed in order from the top of the roof down.
 1. Membrane: Thickness as specified. Mechanically fastened.
 2. Insulation:
 - a. Minimum Total Assembly Thickness: 4 inches.
 - b. Total R Value: 22, minimum.
 - c. Tapered: Slope as indicated, 1/4 inch minimum slope; provide minimum assembly thickness at thinnest point: place tapered insulation on bottom.
 3. Vapor Retarder: As specified.

2.03 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

- A. Membrane: Ethylene-propylene-diene-terpolymer (EPDM); internally reinforced with fabric or scrim; complying with minimum properties of ASTM D4637.
 1. Thickness: 0.060 inch.
 2. Color: Black.
 3. Tensile Strength, ASTM D412 1305 psi.
 4. Ultimate Elongation, ASTM D412: 520 percent.
 5. Tear Strength, ASTM D624: 230 lbf/in.
 6. Water Absorption, ASTM D570: Max 2.0 +/- percent increase in weight, 24 hour immersion.
 7. Water Vapor Permeability, ASTM E96: 2.0 perm inch.
 8. Brittleness Temperature, ASTM D746: -85 deg F.
- B. Seaming Materials: As recommended by membrane manufacturer.
- C. Membrane Fasteners: As recommended by and approved by membrane manufacturer.
- D. Vapor Barrier: Reinforced 3 ply laminated, fire-retardant sheet. Provide manufacturer's recommended tape for seams.
 1. Fire Resistance, ASTM E84: Class A, Flame spread 5, Smoke developed 35.
 2. Moisture Vapor Permeance, ASTM E96: <1.0 perm.
 3. Tensile Strength, ASTM D882: 90 lb-ft.
 4. Products:
 - a. Griffolyn Type 55-FR by Reef Industries Inc.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Flexible Flashing Material: Same material as membrane; conforming to the following:
- F. Adhesives, primers, cleaners, splice tapes and sealants as recommended by membrane manufacturer.

2.04 INSULATION

- A. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289, Type II, Class 2, polymer bonded glass fiber mat both faces and with the following characteristics:
 - 1. Compressive Strength: 20 psi
 - 2. Board Size: 48 x 96 inch.
 - 3. Board Thickness: 2.0 inch, minimum 2 layers.
 - 4. Total Minimum Insulation Thickness: four (4) inches
 - 5. Long-term Thermal Resistance: R-value of 5.6 per inch min.
 - 6. Board Edges: Square.
 - 7. Manufacturer: As recommended by the roofing system manufacturer.

2.05 ACCESSORIES

- A. Roof Expansion Joint: For multi-directional movement; 60 mil black elastomeric bellows with closed cell foam backer and integral 4 inch wide 0.032 aluminum 0.018" flanges for 3 inch wide building expansion joint. Provide in roll length for no joints.
 - 1. Products: Expand-O-Flash Series by Johns Manville.
 - 2. Comparable products by Carlisle, Firestone.
 - 3. Substitutions: See Section 01 60 00 - product Requirements.
- B. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.
- C. Cant and Edge Strips: Perlite board, compatible with roofing materials; cants formed to 45 degree angle.
- D. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
- E. Membrane Adhesive: As recommended by membrane manufacturer.
- F. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- G. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.
- H. Roofing Nails: Galvanized, hot dipped type, size and configuration as required to suit application.
- I. Strip Reglet Devices: Galvanized steel, maximum possible lengths per location, with attachment flanges.
- J. Sealants: One-part urethane as recommended by roofing membrane manufacturer.
- K. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
 - 1. Composition: Molded rubber, slip resistant.
 - 2. Size: 30 x 30 inches.
 - 3. Surface Color: Black.
- L. Miscellaneous Materials and Accessories: As required to provide a complete and warranted roofing system. Manufacturer: Same as membrane system or approved by membrane system manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.

- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips and reglets are in place.
- F. Ensure that treated wood nailers are installed at the perimeter of each roof level, curb, expansion joint, and all roof penetrations as recommended by the membrane manufacturer. Nailers shall be firmly anchored to resist forces of not less than those prescribed by applicable codes and regulations. See Section 06 10 -54 - Wood Blocking and Curbing for additional information. The thickness of the nailers shall be such that the top of the nailer is flush with the surface to which the membrane is attached at the horizontal plane. All preservative treated wood blocking shall be separated from all metals by use of membrane flashing, see Section 06 10 54.
- G. Inspect the substrates scheduled to receive the roofing and flashing systems. Notify the Contractor of any and all defects in the substrates and do not proceed with the work until such defects have been satisfactorily corrected. Before beginning the Work, a representative of the membrane manufacturer shall examine the roof surfaces in order to ensure that they are acceptable for application.

3.02 METAL DECK PREPARATION

- A. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
- B. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
- C. Unacceptable panels should be brought to the attention of the General Contractor and Project Owner's Representative and must be corrected prior to installation of roofing system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 VAPOR RETARDER AND INSULATION - UNDER MEMBRANE

- A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
 - 1. Extend vapor retarder under cant strips and blocking to deck edge.
 - 2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
 - 3. Tape/seal all edges and seams per manufacturer's recommendations.
- B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.
- C. Attachment of Insulation: Mechanically fasten insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual requirements.
- D. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.
- E. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
- F. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
- G. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- H. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches.
- I. Do not apply more insulation than can be covered with membrane in same day.

3.04 MEMBRANE APPLICATION

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.

- C. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
- D. Mechanical Attachment: Apply membrane and mechanical attachment devices in accordance with manufacturer's instructions.
- E. At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 8 inches onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to reglets.
 - 3. Provide securement strips and fasten with seam fastening plates at locations where recommended by the membrane manufacturer.
 - 4. Insert flashing into reglets and secure.
- F. At fascias, extend membrane under fascia metalwork and to the outside face of the wall.
- G. Around roof penetrations, seal flanges and flashings with flexible flashing.
- H. Install roofing expansion joints where indicated. Make joints watertight.
 - 1. Install prefabricated joint components in accordance with manufacturer's instructions.
- I. Coordinate installation of roof drains and sumps and related flashings.
- J. Coordinate installation of associated metalwork flashings installed under other Sections.

3.05 WALWAY PAD INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field quality control and inspection.
- B. Require site attendance of roofing and insulation material manufacturers periodically during installation of the Work.
- C. System Manufacturer's Inspection: Inspection(s) shall be made by a technical representative of the system manufacturer to ascertain that the roofing system has been installed in accordance with the system manufacturer's published specifications and details.
 - 1. The purpose of this inspection is to determine whether a system warranty will be issued by the system manufacturer. Should the technical representative find that the roofing system has not been installed in a manner that qualifies for issuance of the specified system warranty, the system shall not be acceptable to the Owner until the installer has made corrections or repairs, the system has been re-inspected by the system manufacturer's technical representative and the specified roofing system warranty has been issued.
 - 2. Submit a copy of all inspection reports and follow-up reports to the Architect.

3.07 CLEANING

- A. Remove bituminous markings from finished surfaces.
- B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
- C. Repair or replace defaced or damaged finishes caused by work of this section.

3.08 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

SECTION 07 54 00
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Mechanically attached system with thermoplastic roofing membrane.
- B. Adhered system with thermoplastic roofing membrane, where indicated in the Drawings.
- C. Insulation, flat and tapered.
- D. Cover Board.
- E. Vapor retarder.
- F. Deck sheathing.
- G. Membrane flashings.
- H. Metal flashings and fascia related to membrane roofing under the total system warranty are specified in Section 07 62 00 - Sheet Metal Flashing and Trim.
- I. Roofing cant strips, stack boots, roofing expansion joints, and walkway pads.
- J. Installation of roof drains and roof accessories.
- K. Commencement of work by Contractor shall constitute acknowledgement by Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Wood nailers, blocking, cants.
- B. Section 07 62 00 - Sheet Metal Flashing and Trim: Metalwork fascias, copings, counterflashings.
- C. Section 07 72 00 - Roof Accessories: Roof-mounted units; prefabricated curbs.
- D. Division 22 - Plumbing: Roof drains.
- E. Division 23 - HVAC: Roof mounted equipment and stage roof vents.

1.03 REFERENCE STANDARDS

- A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2014.
- B. ASTM C1177 - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2008.
- C. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2014.
- D. ASTM C1396 - Standard Specification for Gypsum Board; 2011.
- E. ASTM D4434 - Standard Specification for Poly(Vinyl Chloride) Sheet Roofing; 2012.
- F. ASTM D6878 - Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing; 2011a.
- G. FM DS 1-28 - Wind Design; Factory Mutual Research Corporation; 2007.
- H. NRCA - The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates.
- I. UL - Roofing Materials and Systems Directory; Underwriters Laboratories Inc.; current edition.
- J. UL - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Convene at least two weeks before starting work of this Section, after the submission and review of roofing and flashing shop drawings, samples and printed data. Review preparation and installation procedures, coordination and scheduling necessary for related work, determine access, staging and storage areas, establish working weather conditions, roofing protection provisions, considerations for safety of building occupants and other relevant issues.
 - 1. Review preparation and installation procedures and coordinating and scheduling required with related work.
 - 2. The following personnel shall be present:
 - a. Contractor (Project Manager, Superintendent)
 - b. Roofing Sub-Contractor (Project Manager, Foreman)
 - c. Roofing and Flashing Materials Manufacturers
 - d. Mechanical Sub-Contractor (Project Manager, Foreman)
 - e. Architect, Project Manager and Owner's Representative
 - 3. Verify compatibility of all materials in contact with roofing, including but not limited to:
 - a. Treated lumber.
 - b. Sealants and adhesives.
 - c. Waterstop membrane.
 - d. Thru wall flashing
 - e. Insulations and roofing boards.
 - f. Vapor Retarders.
 - g. Sheathing.
 - h. Walkway pads.
 - i. All other roofing materials.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.
- C. Specimen Warranty: For approval.
- D. Shop Drawings: Roof details and roof plan.
 - 1. Indicate joint or termination detail conditions, conditions of interface with other materials, mechanical fastener layout, and paver layout.
 - 2. Indicate tapered insulation thicknesses, slopes and layout. Key-in details on roof layout plan.
 - 3. Indicate roof mounted equipment, hatches, etc. on roof plan.
 - 4. Indicate expansion joint details and locations; curb and fascia details; joint or termination detail conditions, conditions of interface with other materials, and roof traffic pad layout. Key-in details on roof layout plan.
- E. Samples:
 - 1. Submit samples 6x6 inches in size illustrating insulation, membrane, underlayments, overlayments, vapor retarders.
- F. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.
- G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- H. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, supplementary instructions given, and substrate approval for installation of systems..
- I. Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.

- J. Concrete Substrates Scheduled to Receive Roofing Systems: Contractor to provide required testing, inspection and documentation in coordination with a manufacturer representative verifying substrate is ready to receive specified systems.
 - 1. Submit documentation to Owner and Architect for record.
- K. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with NRCA Roofing and Waterproofing Manual.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum twenty years of documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this Section:
 - 1. With minimum ten years documented experience.
 - 2. Approved by membrane manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
- B. Store products in weather protected environment, clear of ground and moisture.
- C. Protect foam insulation from direct exposure to sunlight.

1.08 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above manufacturer recommendations.
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.09 WARRANTY

- A. See Section 01 78 00 - Warranties, for additional warranty requirements.
- B. Manufacturer's Total System Warranty: Roofing materials manufacturer shall furnish the Owner a "Total System" warranty insuring a watertight roof for a period of twenty (20) years. The warranty shall cover all repairs necessary over the period up to the original cost of the original roofing contract. Warranty shall include maximum peak gust wind speed coverage of up to 100 mph.
- C. The manufacturer warranty shall also provide labor and material as required to cover leaks caused by accidental punctures: 32 man-hours per year for the specified system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Thermoplastic Polyolefin (TPO) Membrane Materials:
 - 1. Basis of Design: Carlisle SynTec; Sure-Weld.
 - 2. Alternate Manufacturers:
 - a. Firestone Building Products Co.
 - b. GAF;
 - c. GenFlex Roofing Systems.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Rigid polyisocyanurate insulation, HCFC-free, with fiber -reinforced faces:
 - 1. As approved by roofing system manufacturer.

- C. Manufacturer of insulation, fasteners, polmeric components, edgings, cover boards and other accessories or components required to complete the specified system: Same manufacturer as roof membrane or accepted by the manufacturer as compatible.
- D. Manufacturer of Metal Roof Edging: Same manufacturer as roof membrane.
 - 1. Metal roof edging products by other manufacturers are not acceptable.
 - 2. Field- or shop-fabricated metal roof edgings are not acceptable.

2.02 ROOFING SYSTEM DESCRIPTION

- A. Roofing System: Reinforced TPO (Thermoplastic Polyolefin) membrane over insulation, deck sheathing and vapor retarder.
 - 1. Membrane Attachment: Mechanically fastened.
 - 2. Comply with applicable local building code requirements.
 - 3. Provide assembly having Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.
 - 4. Provide assembly complying with Factory Mutual Corporation (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.
- B. Roof System Type 2: Listed in order from the top of the roof down:
 - 1. Membrane: Thickness as specified, mechanically fastened.
 - 2. Insulation:
 - a. Minimum Total Assembly Thickness: 4 inches.
 - b. Total R Value: 22.6, minimum.
 - c. Tapered: Slope as indicated, 1/4 inch minimum slope; provide minimum assembly thickness at thinnest point: place tapered insulation on bottom.
 - 3. Vapor Retarder: As specified.
- C. Roof System Type 3: Listed in order from the top of the roof down.
 - 1. Membrane: Thickness as specified, mechanically fastened.
 - 2. Insulation:
 - a. Minimum Total Assembly Thickness: 4 inches.
 - b. Total R Value: 22.6, minimum.
 - c. Tapered: Slope as indicated, 1/4 inch minimum slope; provide minimum assembly thickness at thinnest point: place tapered insulation on bottom.
 - 3. Vapor Retarder: As specified.
 - 4. Deck Sheathing: As specified.
 - 5. 1 hour UL fire-rated roof system assembly: See Drawings.
- D. Roof System Type 4 (Terraces):
 - 1. Paver System: See Section 32 14 13 Precast Concrete Unit Paving
 - 2. Membrane: Thickness as specified, mechanically fastened.
 - 3. Cover Board: As specified.
 - 4. Insulation:
 - a. Minimum Total Assembly Thickness: 4 inches.
 - b. Total R Value: 22.6, minimum.
 - c. Tapered: Slope as indicated, 1/4 inch minimum slope; provide minimum assembly thickness at thinnest point: place tapered insulation on bottom.
 - 5. Vapor Retarder: As specified.
- E. Roof System Type 5 (Terrace at Garage Entry):
 - 1. Membrane: Thickness as specified, fully adhered.

2.03 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

- A. Membrane:
 - 1. TPO Material: Thermoplastic polyolefin complying with ASTM D 6878, scrim reinforced.
 - 2. Reinforcing: Fiberglass reinforced membrane with factory 9 oz. feltback Fabric backing.
 - 3. Thickness: 0.060 inch, minimum.

4. Sheet Width: Factory fabricated into largest sheets possible.
 5. Color(s): Gray.
 6. Petroleum based products, certain chemicals and waste products may not be compatible with the membrane. Protection membrane shall be provided if required at locations such as roof mounted kitchen cooking exhaust equipment, kitchen equipment refrigerant compressors, etc.
- B. Seaming Materials: Heat welded, As recommended by membrane manufacturer.
- C. Fasteners: As recommended and approved by membrane manufacturer.
1. Membrane and Other Miscellaneous Fasteners: Type and size as required by roof membrane manufacturer for roofing system and warranty to be provided; use only fasteners furnished by roof membrane manufacturer.
- D. Flashing membranes and pre-molded flashings as recommended by membrane manufacturer.
- E. Adhesives, primers, cleaners, splice tapes and sealants as recommended by membrane manufacturer.
- F. Roof Walkway Pads: Sure-Flex PVC Heat Weldable Walkway Rolls by Carlisle, 80 mils thick.
- G. Vapor Barrier: Fire-retardant, reinforced. Provide manufacturer's recommended tape for seams.
1. Fire Resistance, ASTM E84: Flame Spread of 25 or less and Smoke Developed of 450 or less.
 2. Vapor Permeance, ASTM E96: Less than 1.0 perm.
 3. Products:
 - a. Griffolyn Type 55-FR by Reef Industries Inc.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 DECK SHEATHING AND COVER BOARDS

- A. Deck Sheathing: Glass mat faced gypsum panels, ASTM C1177, fire resistant type, 5/8 inch thick.
1. Products:
 - a. Georgia-Pacific; DensDeck.
 - b. National Gypsum Company; DEXcell Glass Mat Roof Board.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Cover Board: Polyisocyanurate board, complying with ASTM C1289, Type II, Class 4, glass fiber mat both faces, and with the following characteristics:
1. Compressive Strength: 100 psi.
 2. Board Size: 48 x 96 inch.
 3. Board Thickness: 0.5 inch.
 4. Manufacturers:
 - a. Hunter Panels, LLC; H-Shield HD
 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 INSULATION

- A. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289, Type II, Class 1, cellulose felt or glass fiber mat both faces; Grade 3 and with the following characteristics:
1. Compressive Strength: 25 psi
 2. Board Size: 48 x 96 inch.
 3. Board Thickness: 2 inch each. Minimum 2 layers required.
 4. Tapered Board: Slope as indicated; minimum thickness 1-1/2 inch; fabricate of fewest layers possible.
 5. Long Term Thermal Resistance: Minimum R-value of 5.6 per inch min.
 6. Board Edges: Square.
 7. Product (Basis of Design): Carlisle HP-H Polyiso by Carlisle Syntec
 8. Substitutions: See Section 01 60 00 - Product Requirements.

9. Provide tapered boards where indicated for sloping to drain. Fabricate with taper of 1/4 inch per foot minimum. All roof drains shall be sumped in a 4' x 4' area.

2.06 ACCESSORIES

- A. Roofing Expansion Joint: Roofing manufacturer's standard detail with tubular foam, support membrane and cover membrane.
- B. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.
- C. Cant and Edge Strips: Wood fiberboard, compatible with roofing materials; cants formed to 45 degree angle.
- D. Sheathing Adhesive: Non-combustible type, for adhering gypsum sheathing to metal deck.
- E. Sheathing Joint Tape: Paper type, 4 inch wide, self adhering.
- F. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
 1. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
- G. Adhesive: As recommended by the roofing system manufacturer.
- H. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- I. Thinners and Cleaners: As recommended by the roofing system manufacturer, compatible with membrane.
- J. Roofing Nails: Galvanized, hot dipped type, size and configuration as required to suit application.
- K. Strip Reglet Devices: Galvanized steel, maximum possible lengths per location, with attachment flanges.
- L. Sealants: As recommended by the roofing system manufacturer.
- M. Walkway Pads: 30" x 30", non-slip, type as recommended by the roofing system manufacturer.
 1. Surface Color: Gray.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Perform work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.
- B. Do not apply roofing membrane during unsuitable weather.
- C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.02 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

- F. Ensure that treated wood nailers are installed at the perimeter of each roof level, curb, expansion joint, and all roof penetrations as recommended by the membrane manufacturer. Nailers shall be firmly anchored to resist forces of not less than those prescribed by applicable codes and regulations. See Section 06 10 -54 - Wood Blocking and Curbing for additional information. The thickness of the nailers shall be such that the top of the nailer is flush with the surface to which the membrane is attached at the horizontal plane. All preservative treated wood blocking shall be separated from all metals by use of membrane flashing, see Section 06 10 54.
- G. Inspect the substrates scheduled to receive the roofing and flashing systems. Notify the Contractor of any and all defects in the substrates and do not proceed with the work until such defects have been satisfactorily corrected. Before beginning the Work, a representative of the membrane manufacturer shall examine the roof surfaces in order to ensure that they are acceptable for application.

3.03 CONCRETE DECK PREPARATION

- A. Fill surface honeycomb and variations with latex filler.
- B. Confirm dry deck by moisture meter with 12 percent moisture maximum.
- C. Contractor to provide required testing and documentation in coordination with a manufacturer representative verifying substrate is ready to receive specified systems.
 - 1. Do not proceed with installation without written acceptance by system manufacturer.
 - 2. Submit documentation to Owner and Architect for record.

3.04 METAL DECK PREPARATION

- A. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
- B. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
- C. Unacceptable panels should be brought to the attention of the General Contractor and Project Owner's Representative and must be corrected prior to installation of roofing system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Install deck sheathing on metal deck:
 - 1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
 - 2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.
 - 3. Tape joints.

3.05 VAPOR RETARDER AND INSULATION - UNDER MEMBRANE

- A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
 - 1. Extend vapor retarder under cant strips and blocking to deck edge.
 - 2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
 - 3. Tape/seal all edges and seams per manufacturer's recommendations.
- B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.
- C. Attachment of Insulation:
 - 1. Install insulation over substrate with boards butted tightly together with no joints or gaps greater than 1/4 inch. Stagger joints both horizontally and vertically for multiple insulation layers.
 - 2. Mechanically fasten insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual requirements.
- D. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.

- E. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
- F. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
- G. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- H. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches.
- I. Do not apply more insulation than can be covered with membrane in same day.

3.06 MEMBRANE APPLICATION

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
- D. Mechanical Attachment: Apply membrane and mechanical attachment devices in accordance with manufacturer's instructions.
- E. At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 8 inches onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to reglets.
 - 3. Provide securement strips and fasten with seam fastening plates at locations where recommended by the membrane manufacturer.
 - 4. Insert flashing into reglets and secure.
- F. Around roof penetrations, seal flanges and flashings with flexible flashing.
- G. Install roofing expansion joints where indicated. Make joints watertight.
 - 1. Install prefabricated joint components in accordance with manufacturer's instructions.
- H. Coordinate installation of roof drains and sumps and related flashings.
- I. Coordinate installation of associated metalwork flashings installed under other Sections.

3.07 WALWAY PAD INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.08 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field quality control and inspection.
- B. Require site attendance of roofing and insulation material manufacturers periodically during installation of the Work.
- C. Require site attendance of roofing material manufacturer's representative during installation of the Work and upon completion of the installation, to ascertain that the roofing system has been installed according to the roofing system manufacturer's published specifications and details.
 - 1. The purpose of this inspection is to determine whether a system warranty will be issued by the system manufacturer. Should the technical representative find that the roofing system has not been installed in a manner that qualifies for issuance of the specified system warranty, the system shall not be acceptable to the Owner until the installer has made corrections or repairs, the system has been re-inspected by the system manufacturer's technical representative and the specified roofing system warranty has been issued.
 - 2. Submit a copy of the roofing system manufacturer's representative's report to the Architect and Contractor.
 - 3. Make all corrections recommended by the manufacturer.

4. Provide all required documents to the roofing materials manufacturer as required for issuance of the specified warranty.

3.09 CLEANING

- A. Remove bituminous markings from finished surfaces.
- B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
- C. Repair or replace defaced or damaged finishes caused by work of this section.

3.10 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings and counterflashings.
- B. Sealants for joints within sheet metal fabrications.
- C. Fabricated sheet metal fascias and cleats.
- D. Reglets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Wood blocking for metal flashings.
- B. Section 07 31 13 - Asphalt Shingles: Non-metallic flashings associated with shingle roofing.
- C. Section 07 53 00 - Elastomeric Membrane Roofing: Membrane roofing system requiring metalwork for Total System warranty.
- D. Section 07 54 00 - Thermoplastic Membrane Roofing: Membrane roofing system requiring metalwork for Total System warranty.
- E. Section 07 72 00 - Roof Accessories: Manufactured metal roof curbs.

1.03 REFERENCE STANDARDS

- A. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels; 2013.
- B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.
- C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- D. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.
- F. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2012)e1.
- G. SMACNA - Architectural Sheet Metal Manual; 2012.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene at least two weeks before starting work of this Section.

1.05 PERFORMANCE REQUIREMENTS

- A. General: Install flashings that are watertight; will not permit the passage of liquid water; and will withstand wind loads, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details. Key into roof plan shop drawing, see roofing Section.
- C. Samples:
 - 1. Submit samples each 4x4 inch in size, illustrating metal materials, thickness, and colors.
 - 2. Submit samples 8" long in size, illustrating roofing fascia system.

1.07 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA 1793 and CDA A4050 requirements and standard details, except as otherwise indicated.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with ten years of documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

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

1.09 WARRANTY

- A. The flashing and roofing subcontractor hereby guarantees that roof metalwork, flashings, roofing, roof insulation and roof accessories will be free from defective materials and workmanship for a period of two (2) years from the date of Substantial Completion. Upon notification of any such defects within said guarantee period the roofing and flashing subcontractor shall promptly make all necessary repairs and replacements at no cost or expense to the Owner. This warranty shall be signed and countersigned by the installer (Roofer) and the Contractor.
- B. Metal Flashings Warranty under Roofing Manufacturer's Total System Warranty: See Sections 07 53 00 Elastomeric Membrane Roofing and 07 54 00 Thermoplastic Membrane Roofing.
- C. Pre-finished Aluminum: Finish shall be warranted against premature failure for twenty (20) years.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Membrane Roofing Fascia System: Pre-finished aluminum fascia with continuous anchor bar/cleat. Color as selected from the manufacturer's standard color range.
 - 1. Product: As approved by the selected roofing system manufacturer for a Total System Warranty. Examples include: SecurEdge 2000 as manufactured by Carlisle Syn-Tec, Anchor-tite as manufactured by Metal-era.
 - 2. Extruded anchor bar / cleat: 0.100 inch.
 - 3. Fascia: 0.040 inch.
 - 4. Accessories: As recommended by the system manufacturer.
 - 5. Fasteners: Anchors with rubber washers as recommended by the system manufacturer.
 - 6. Sealant: Non-curing as recommended by the system manufacturer.
- B. Pre-Finished Aluminum: ASTM B209; 0.032 inch thickness or as otherwise indicated; plain finish shop pre-coated with fluoropolymer coating.
 - 1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system; Kynar or Duranar by PPG.
 - 2. Color: As selected by Architect from manufacturer's standard colors.
 - 3. For Total System Warranty projects, metalwork shall be as approved by the membrane roofing manufacturer.

2.02 ACCESSORIES

- A. Primer: Zinc chromate type.
- B. Protective Backing Paint: Zinc molybdate alkyd.
- C. Sealant to be Concealed in Completed Work: Non-curing butyl sealant.
- D. Sealant to be Exposed in Completed Work: ASTM C920; elastomeric sealant, 100 percent silicone with minimum movement capability of plus/minus 25 percent and recommended by manufacturer for substrates to be sealed; clear.
- E. Plastic Cement: ASTM D4586, Type I.

- F. Reglets: Surface mounted type, galvanized steel; face and ends covered with plastic tape.
- G. Fasteners for Aluminum: Stainless steel ring nails; 12 gage with 1/4" diameter, flat head, annular threaded, needle point, length as required to obtain 1-1/4" embedment into blocking/framing and full depth into plywood.
- H. Anchors for Flashing to Concrete or Masonry: 1/4" diameter, lengths as required to obtain 1-1/2" penetration into masonry backup. Unless otherwise indicated, provide 3 inch edge distance.
 - 1. Product: Nylon Nail-in with stainless steel drive pin manufactured by Powers Fasteners Inc.
- I. Sealant: Silicone specified in Section 07 90 05. Use for aluminum flashing joint seal.

2.03 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.. Form on a bending brake. Perform shaping, trimming, and hand seaming in the shop to the maximum extent possible.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams. Form metal with full regard for expansion and contraction to avoid buckling or other deformation in service. All lines and arrisses shall be straight and crisp except where thickness of metal dictates radius bend.
- E. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.
- F. Pre-fabricate corners with joints locked, riveted and soldered watertight, and where indicated from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
- G. Unless indicated otherwise, provide expansion joints at 24 feet on centers maximum and at 2 feet from all changes in flashing direction (each side) and from all terminations of flashing.
- H. Space rivets 1 inch on center unless indicated otherwise.
- I. Provide backer plates as required at through-wall flashing transitions and corners to fully solder watertight. Backer plates shall be continuous to cover gaps to be overlain by membrane flashing at all deck and column to wall transitions. Secure to framing or plywood at 6" centers and within 1/2" of corners and edges.
- J. Fabricate flashings to allow toe to extend 2 inches over roofing terminations. Return and brake edges.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install surface mounted reglets true to lines and levels. Seal top of reglets with sealant.
- C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 GENERAL REQUIREMENTS FOR METAL FLASHING

- A. Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather, without failing. Fabricate and install flashings

and roof edges to fully comply with the recommendations of Factory Mutual (FM) Loss Prevention Data Sheet 1-49 for the applicable wind zone.

- B. Schedule and coordinate sheet metal installations with the work of other trades where it is integral or continuous therewith. Materials furnished under this Section that are to be built-in by other trades shall be delivered to the site in sufficient time to avoid delays to construction progress. Instruct other trades concerning the location and placement of reglets, wood nailers, and cleats.
- C. Surfaces to which roofing and sheet metal are to be applied shall be even, smooth, sound, thoroughly clean and dry and free from projecting nail heads or other defects that would affect the application. Report in writing any unsatisfactory surfaces to the Contractor.
- D. Where flashing abuts or members into adjacent dissimilar metals, the juncture shall be executed in a manner that will facilitate drainage and thus minimize the possibility of galvanic action. Note: All metalwork shall be isolated from contact with pressure treated wood products, using roofing membrane, felts, or approved coatings.
- E. All accessories or other items essential to the completeness of the sheet metal installation, though not specifically shown or specified, shall be provided. All such items, unless otherwise indicated on Drawings or specified, shall be of the same kind of material as the item to which applied and the gauges shall conform to recognized industry standards of sheet metal practice.
- F. Provide expansion joints in sheet metal work at intervals not greater than forty (40') feet. Expansion joints shall be fabricated in accordance with the recommendations of the Architectural Sheet Metal Manual (SMACNA) and as specified herein.
 - 1. Begin expansion joint construction by setting an 8" wide cleat. Lapp ends of metal work over base sheet, leaving 1/2" clear space between butt ends. Set ends on full bed of sealant. Cover entire joint assembly with a 4 inch wide metal cover, finish to match other metal work and secured allowing for movement.
- G. Fabricate and install sheet metal with lines, arises, and angles sharp and true and plane surfaces free from objectionable wave, warp, or buckle. Exposed edges of sheet metal shall be folded back to form a 1/2" wide hem on the side concealed from water leakage under all weather conditions. The workmanship and methods employed for framing, anchoring, cleating, and the expansion and contraction of sheet metal work shall conform to applicable details and description as indicated in current edition of the following publications unless other methods are indicated on project Drawings or specified herein.
 - 1. Architectural Sheet Metal Manual as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc., and hereinafter referred to as "The SMACNA Manual".
- H. All ferrous metal work shall be zinc coated and finished as specified elsewhere herein. Touch-up all field cuts and minor scratches with approved zinc rich primer and finish coat to match adjacent finishes.
- I. All metal work terminating on roofing shall be provided with flanges for nailing. Wood nailers shall be provided beneath flanges and roofing for nailing of the metal flanges.
- J. Provide cleats, edge and drip strips where sheet metal extends over edges and where necessary to secure sheet metal work at fascias, and elsewhere. Form edge strips in lengths of 8' or 10'. The ends shall be butted together, leaving approximately 1/4" space for expansion. Secure to building construction with fasteners spaced not over 12" on centers. Install strips in continuous, long lengths to allow metal work to be hooked over lower edge at least 1/2".
- K. Flash intersections of roofs with vertical surfaces as detailed and indicated on the Drawings, or otherwise required to provide watertight construction and to suit job conditions.
- L. Seams shall always be made in direction of flow.
- M. Fabricated fascias shall be sized and shaped to profiles indicated, using sheets 8' to 10' long. Lower edge shall hook a minimum of 1/2" over previously placed continuous edge cleats.

3.04 INSTALLATION

- A. Conform to drawing details. Installations shall conform to SMACNA Architectural Sheet Metal Manual recommendations and National Roofing Association Manual recommendations.
- B. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
- C. Apply plastic cement compound between metal flashings and felt flashings.
- D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- E. Seal metal joints watertight.

3.05 INSTALLATION OF TOTAL SYSTEM ROOFING METALWORK

- A. Confirm that roofing membrane shall extend over face of perimeter blocking and weather barrier transition membrane for wall / eave construction.
- B. Set anchor cleat in a continuous bead of sealant and secure with recommended fasteners.
- C. At end joints and corners of anchor cleat, install manufacturer's rubber splice material to maintain a continuous seal providing a watertight edge.
- D. Install fascia on the anchor cleat in accordance with manufacturer's recommendations.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.
- C. See Section 07 53 00 Elastomeric Membrane Roofing and 07 54 00 Thermoplastic Membrane Roofing, for field inspection requirements.

3.07 SCHEDULE

- A. Fascia:
 - 1. Aluminum:.050
- B. Cleats:
 - 1. Aluminum:.060
- C. Scuppers:
 - 1. Aluminum:.060
- D. Drip Edge:
 - 1. Aluminum:.040
- E. Base Flashing:
 - 1. Aluminum:.040
- F. Coping, Cap, Parapet, Sill and Ledge Flashings:
 - 1. Aluminum:.040
- G. Miscellaneous Flashings:
 - 1. Aluminum:.040 or as required, unless otherwise indicated on Drawings.

3.08 CLEANING AND PROTECTION

- A. Clean all metalwork to remove all fingerprints, oils, etc.
- B. Remove from roof surfaces all scraps and metal debris immediately. Extreme care shall be exercised to prevent sharp metal scraps or waste nails from coming into contact with membrane materials.

END OF SECTION

SECTION 07 72 00
ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof hatches and hatch guards.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing.
- B. Section 07 53 00 - Elastomeric Membrane Roofing.
- C. Section 07 54 00 - Thermoplastic Membrane Roofing.
- D. Section 07 62 00 - Sheet Metal Flashing and Trim: Roof accessory items fabricated from sheet metal.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1910.23 - Guarding floor and wall openings and holes; current edition.
- B. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.
- C. ASTM A792 - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2010.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
- E. OSHA 29 CFR 1926.502 - Fall Protection.
- F. OSHA 29 CFR 1910.23 - Guarding Floor and Wall Opening Holes.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used and installation instructions.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Submit shop drawings indicating type, configuration, and dimensions of all materials. Shop drawings shall indicate fastening and anchoring methods, flashing, details, and locations of all seams, joints, and other provisions necessary for thermal expansion and condensation control.
- D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
- E. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

1.06 WARRANTY

- A. Provide manufacturer's standard product warranty for roof hatches for a period of five (5) years against defects in materials and/or workmanship.

PART 2 PRODUCTS

2.01 ROOF HATCHES

- A. Roof Hatches: Factory-assembled aluminum frame and cover, complete with operating and release hardware.
 - 1. Style: Provide flat metal covers unless otherwise indicated.
 - 2. Mounting: Provide frames and curbs suitable for mounting on flat roof deck.
 - 3. Size(s): As indicated on Drawings; single-leaf style unless indicated as double-leaf.
 - 4. For Alternating Tread Device Access: Single leaf; 30 by 54 inches.
 - a. Product: Type NB-50T by Bilco Co., Model RH by Nystrom Products, Inc.
- B. Frames/Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
 - 1. Material: Mill finished aluminum, 11 gage, 0.125 inch thick.
 - 2. Insulation: 2 inches rigid polyisocyanurate, R12, located on outside face of curb.
 - 3. Curb Height: 12 inches from finished surface of roof, minimum.
- C. Metal Covers: Flush, insulated, hollow metal construction.
 - 1. Capable of supporting 40 psf live load, with a maximum deflection of 1/150 of span or 20 psf wind uplift.
 - 2. Material: Mill finished aluminum; outer cover 0.125 inch thick, liner 0.04 inch thick.
 - 3. Insulation: 2 inches rigid polyisocyanurate, R12, located inside hollow cover.
 - 4. Gasket: EPDM, continuous around cover perimeter.
- D. Safety Railing System: Manufacturer's standard accessory safety rail system mounted directly to curb.
 - 1. Comply with OSHA 29 CFR 1910.23, with a safety factor of two.
 - 2. Posts and Rails: Fiberglass reinforced polymer.
 - 3. Gate: Same material as railing; automatic closing with latch.
 - 4. Finish: Manufacturer's standard; molded in integral safety yellow.
 - 5. Gate Hinges and Post Guides: ASTM B221 (ASTM B221M), 6063 alloy, T5 temper aluminum.
 - 6. Mounting Brackets: Hot dipped galvanized steel, 1/4 inch thick, minimum.
 - 7. Fasteners: Type 316 stainless steel.
- E. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
 - 1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load. Opening of hatch shall be in a controlled manner to avoid damage to surrounding roof surfaces.
 - 2. Hinges: Heavy duty pintle type. Cover shall automatically lock in open position with rigid hold open arm and grip handle to release.
 - 3. Hold open arm with vinyl-coated handle for manual release. Provide interior and exterior handles for stage vents.
 - 4. Latch: Upon closing, engage latch automatically and reset manual release. Latches shall withstand 30 psf wind uplift forces.
 - 5. Manual Release: Pull handle on interior and exterior.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Prior to proceeding with an installation, verify that all necessary blocking, bracing, and supports have been provided.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

3.04 CLEANING

- A. Clean installed work to like-new condition.
- B. Position roof hatches as required to provide a minimum distance to roof edge of 30 inches at hatch ladder access side, as required by OSHA.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07 81 00
APPLIED FIREPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fireproofing of interior and indirect weather exposure structural steel.

1.02 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel Framing.
- B. Section 05 21 00 - Steel Joist Framing.
- C. Section 05 31 00 - Steel Decking.
- D. Section 07 84 00 - Firestopping.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- B. ASTM E605 - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2011).
- C. ASTM E736 - Standard Test Method For Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members; 2000 (Reapproved 2011).
- D. ASTM E759 - Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2011).
- E. ASTM E760 - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2011).
- F. ASTM E859 - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2011).
- G. ASTM E937 - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2011).
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2013.
- I. UL - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with placement of ceiling hanger tabs, mechanical component hangers, and electrical components.
- B. Pre-installation Meeting: Convene one week before starting work of this Section.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
- B. Product Data: Provide data indicating product characteristics.
- C. Test Reports: Independent testing agency reports for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, for:
 - 1. Bond Strength.
 - 2. Bond Impact.
 - 3. Compressive Strength.
 - 4. Fire tests using substrate materials similar those on Project.
 - 5. Primers and other coatings applied to structural steel in the shop or field are compatible with fireproofing application.

- D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.
- E. Manufacturer's Certificate: Certify that sprayed-on fireproofing products meet or exceed requirements of contract documents.
- F. Manufacturer's Field Reports: Indicate environmental conditions under which fireproofing materials were installed. Certify each fireproofing product is fully compatible with adhesives, primers, and other surface coatings on substrates intended to receive fireproofing.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section, with not less than ten years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, and:
 - 1. Having minimum five years of documented experience.
 - 2. Approved by manufacturer.

1.07 REGULATORY REQUIREMENTS

- A. Environmental Compliance: Provide fireproofing products containing no detectable asbestos as determined according to the method specified in 40 CFR Part 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy.

1.08 MOCK-UP

- A. Construct mock-up, 100 square feet in size.
- B. Conform to project requirements for fire ratings.
- C. Locate where directed.
- D. Examine installation within one hour of application to determine variances from specified requirements due to shrinkage, temperature, and humidity.
- E. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary. Remove materials and re-construct mock-up.
- F. Mock-up may remain as part of the Work.

1.09 DELIVERY, STORAGE AND PROTECTION

- A. Delivery: Materials shall be delivered in original sealed containers, clearly marked with suppliers name, brand name and type of material, and bearing U.L. label.
- B. Storage and Handling: Materials shall be stored off the ground and protected from the weather, in strict compliance with the manufacturer's recommendations.

1.10 FIELD CONDITIONS

- A. Do not apply spray fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
- B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
- C. Provide temporary enclosure to prevent spray from contaminating air.

1.11 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
 - 1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
 - 2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sprayed-On Fireproofing:
 - 1. Carbolite Company
 - 2. Grace Construction Products
 - 3. Isolatek International Inc
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FIREPROOFING ASSEMBLIES

- A. Provide a fire rated assembly rating of one (1) hour for roof and secondary members assembly to UL Design No. D902 and two (2) hours for Primary Structural Framing, Bearing Walls and Floor Construction including Secondary Members assembly to UL Design No. D902.

2.03 MATERIALS

- A. Sprayed Fire-Resistive Material for Interior Applications and Indirect Weather Exposure: Manufacturer's standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance.
 - 1. Composition: Cementitious, not mineral-fiber-based.
 - 2. Bond Strength, ASTM E736: 150 psf, minimum, when set and dry.
 - 3. Dry Density: As required by fire resistance design.
 - 4. Effect of Impact on Bonding, ASTM E760: No cracking, spalling or delamination.
 - 5. Corrosivity, ASTM E937: No evidence of corrosion.
 - 6. Air Erosion Resistance, ASTM E859: Weight loss of 0.025 g/sq ft, after 24 hrs.
 - 7. Surface Burning Characteristics, ASTM E84: Maximum flame spread of 0 and maximum smoke developed of 0.
 - 8. Effect of Deflection, ASTM E759: No cracking, spalling, or delamination'
 - 9. Fungal Resistance: No growth after 28 days when tested according to ASTM G21.
 - 10. Products:
 - a. Basis of Design: Isolatek International; CAFCO Blaze-Shield II.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 ACCESSORIES

- A. Primer Adhesive: Of type recommended by fireproofing manufacturer.
- B. Water: Clean, potable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive fireproofing.
- B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
- C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
- D. Verify that voids and cracks in substrate have been filled. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION

- A. Perform tests as recommended by fireproofing manufacturer in situations where adhesion of fireproofing to substrate is in question.
- B. Remove incompatible materials that could affect bond by scraping, brushing, scrubbing, or sandblasting.

- C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
- D. Apply fireproofing manufacturer's recommended bonding agent on primed steel.
- E. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.
- F. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION

- A. Apply primer adhesive in accordance with manufacturer's instructions.
- B. Apply fireproofing in thickness and density necessary to achieve required ratings, with uniform density and texture.
- C. In exposed locations, trowel surface smooth and form square edges, using tools and procedures recommended by fireproofing manufacturer.

3.04 FIELD QUALITY CONTROL

- A. The Owner's testing and inspection agency shall test and inspect fireproofing after application and curing, prior to its concealment.
- B. Fireproofing shall be tested in accordance with ASTM E605 and ASTM E736 in areas as described below. Do not proceed with fireproofing of next area until test results for previously completed work indicate compliance with requirements.
 - 1. Thickness: Floor, Roof and Wall Assemblies: Floor, roof and wall assembly thickness measurements shall be taken at not less than four (4) random locations for each 1,000 sf of floor, roof and wall surface.
 - 2. Thickness: Structural Framing Members: Structural framing members thickness measurements shall be taken at not less than 25% of the structural members on each floor.
 - 3. Density: Samples for density determination shall be taken at a rate of not less than one test for each 10,000 sf of sprayed areas in each story, but in no case shall there be less than two per story.
 - 4. Bond Strength: Floor, Roof, and Wall Assemblies: Samples for cohesion/adhesion shall be taken on thoroughly dried material at the rate of not less than one test for each 10,000 sf, or part thereof of the sprayed areas in each story.
 - 5. Bond Strength: Structural Framing Members: Samples for cohesion/adhesion shall be taken on thoroughly dried material at the rate of not less than one test for each type of structural framing member for each 10,000 sf of floor area or part thereof in each story.
- C. Testing agency shall report test results promptly and in writing to the Contractor, Owner, and Architect.
- D. Repair or replace fireproofing within areas where test results indicate fireproofing does not comply with requirements.
- E. Apply additional fireproofing per manufacturer's directions where test results indicate that the thickness does not comply with specified requirements.
- F. Where fireproofing is removed and replaced or repaired, additional testing will be performed to determine compliance with specified requirements. Any re-tests for areas not in compliance shall be paid for by the Contractor.

3.05 CLEANING

- A. Remove excess material, overspray, droppings, and debris.
- B. Remove fireproofing from materials and surfaces not required to be fireproofed.
- C. At exposed fireproofing, clean surfaces that have become soiled or stained, using manufacturer's recommended procedures.

- D. Remove overspray from piping, electrical devices, ductwork, etc. All floor areas shall be broom cleaned.

END OF SECTION

SECTION 07 81 23
INTUMESCENT MASTIC FIREPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Thin-film intumescent fire-resistive coatings for exposed structural steel.
- B. Protective and/or decorative topcoats.

1.02 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel Framing.
- B. Section 07 81 00 - Applied Fireproofing: Conventional cementitious and mineral fiber fireproofing.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2012.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Performance characteristics and test results.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods.
- C. Selection Samples: For decorative top coat, color chips representing manufacturer's full range of available colors and sheens.
- D. Verification Samples: For each thickness, color, sheen, and finish required, samples not less than 4 inches square on steel substrate, illustrating finished appearance.
- E. Test Reports: Published fire-resistive designs for structural elements of the types required for the project, indicating hourly ratings of each assembly.
- F. Certificates: Certify that intumescent fireproofing provided for this project meets or exceeds specified requirements in all respects.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company that specializes in manufacturing the type of products specified, with minimum of 10 years of documented experience.
- B. Installer Qualifications: Approved, certified, or supervised by manufacturer of intumescent fireproofing, with not less than 5 years of documented experience.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship. Approved mock-up will serve as a standard of comparison for subsequent work of this section.
 - 1. Finish at least 100 sq ft of steel in areas designated by Architect.
 - 2. Evaluate mock-up for compliance with specified requirements, including thickness and finish texture.
 - 3. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 4. Refinish mock-up area as required to produce acceptable work.
 - 5. Approved mock-up may remain as part of the project.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened containers with identification labels and testing agency markings intact and legible.
- B. Store products in manufacturer's unopened packaging until ready for installation.
 - 1. Store at temperatures not less than 50 degrees F in dry, protected area.
 - 2. Protect from freezing, and do not store in direct sunlight.
 - 3. Dispose of any materials that have come into contact with contaminants of any kind prior to application.
- C. Dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Protect areas of application from windblown dust and rain.
- B. Maintain ambient field conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under ambient conditions outside manufacturer's absolute limits.
 - 1. Provide temporary enclosures as required to control ambient conditions.
 - 2. Do not apply intumescent fireproofing when ambient temperatures are below 50 degrees F without specific approval from manufacturer.
 - 3. Maintain relative humidity between 40 and 60 percent in areas of application.
 - 4. Maintain ventilation in enclosed spaces during application and for not less than 72 hours afterward.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Intumescent Fireproofing:
 - 1. Basis of Design: Isolatek International
 - a. Interior Applications: CAFCO SprayFilm WB3.
 - b. Exterior Applications: CAFCO SprayFilm WB4 with Topseal.
 - 2. Albi Manufacturing, Division of StanChem Inc.
 - 3. Carboline Company.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SYSTEM REQUIREMENTS

- A. Fireproofing: Provide intumescent thin-film fire-resistive coating systems tested by an independent testing agency in accordance with ASTM E119 and acceptable to Authority Having Jurisdiction.
 - 1. Applications: See Drawings for applications.
 - 2. Provide assemblies listed by UL or FM and bearing listing agency label or mark.
- B. Structural Steel Columns: Fire resistance rating of 2 hours; Design Number X649.
- C. Structural Steel Beams: Fire resistance rating of 2 hours; Design Number D601.
- D. Exposed Steel Deck: Fire resistance rating of 2 hours; Design Number D601.

2.03 MATERIALS

- A. Fire-Resistive Coating System: Thin film intumescent coating system for the fire protection of structural steel.
 - 1. Surface Burning Characteristics, ASTM E84:
 - a. Flame Spread Index: 25, maximum.
 - b. Smoke Developed Index: 50, maximum.
 - 2. For Interior Use:
 - a. Use only water-based products.
 - 3. For Exterior Use:

- a. Use only water-based products.
 - b. Finish: High Quality Architectural.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Protective and Decorative Top Coating: As recommended by fireproofing manufacturer for exposure conditions.
1. Color and Gloss: As selected by the Architect.
- C. Sealers and Primer: As required by tested and listed assemblies, and as recommended by fireproofing manufacturer to suit specific substrate conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates to determine if they are in satisfactory condition to receive intumescent fireproofing. Verify that they are clean and free of oil, grease, incompatible primers, or other foreign substances capable of impairing bond to fireproofing system.
- B. Do not begin installation until substrates have been properly prepared. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Thoroughly clean surfaces to receive fireproofing.
- B. Prepare steel to be fireproofed in accordance with SS PC-SP3 Power Tool Cleaning Standard.
- C. Repair substrates to remove surface imperfections that could affect uniformity of texture and thickness of fireproofing system. Remove minor projections and fill voids that could telegraph through the finished work.
- D. Cover or otherwise protect other work that might be damaged by fallout or overspray of fireproofing system. Provide temporary enclosures as necessary to confine operations and maintain required ambient field conditions.

3.03 INSTALLATION

- A. Comply with manufacturer's instructions for particular conditions of installation in each case.
- B. Apply manufacturer's recommended primer to required coating thickness.
- C. Apply fireproofing to full thickness over entire area of each substrate to be protected. Apply coats at manufacturer's recommended rate to achieve dry film thickness required for fire resistance ratings designated for each condition.
- D. Apply intumescent fireproofing by spraying to maximum extent possible. If necessary, complete coverage by roller application or other method acceptable to manufacturer.
- E. Achieve uniform finished appearance complying with approved mock-up.

3.04 FIELD QUALITY CONTROL

- A. Testing Laboratory: Owner will employ and pay for field quality control testing of intumescent fireproofing by an independent testing laboratory.
- B. Repair or replace fireproofing at locations where test results indicate fireproofing does not meet specified requirements.

3.05 CLEANING

- A. Immediately after installation of fireproofing in each area, remove overspray and fallout from other surfaces and clean soiled areas.

3.06 PROTECTION

- A. Protect installed intumescent fireproofing from damage due to subsequent construction activities, so fireproofing is without damage or deterioration at time of Substantial Completion.

- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of all penetrations and interruptions to fire rated assemblies, smoke barriers, non-fire rated floor assemblies, whether indicated on drawings or not, and other openings indicated.
- C. Identification signage.

1.02 RELATED REQUIREMENTS

- A. Section 07 21 00 - Insulation: Fiber Firestopping Insulation.
- B. Section 09 21 16 - GYPSUM BOARD ASSEMBLIES: Gypsum wallboard fireproofing.
- C. Division 21 - Fire Protection: Firestopping of fire protection work.
- D. Division 22 - Plumbing: Firestopping of plumbing work.
- E. Division 23 - HVAC: Firestopping of heating, ventilating and air conditioning work.
- F. Division 26 - Electrical: Firestopping of electrical work.

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2012.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
- C. ASTM E1966 - Standard Test Method for Fire Resistive Joint Systems; 2007 (Reapproved 2011).
- D. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2010.
- E. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2013.
- F. ITS - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- G. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- H. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.
- I. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Underwriters Laboratories Inc.; 2004.
- J. UL - Fire Resistance Directory; ; current edition.

1.04 DEFINITIONS

- A. Annular Space is the opening around an item (pipe, duct, etc.) penetrating a construction assembly.
- B. Fire-resistance is the property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases, or flames under conditions of use.
- C. Fire-resistive joint system is the assemblage of specific materials or products that are designed, tested and fire-resistance rated in accordance with ASTM E-119 to resist for a prescribed period of time the spread of fire through joints in or between fire-resistance rated assemblies.
- D. Firestopping is a specific assembly of materials or products fill openings and annular spaces around penetrating items (such as cables, cable trays, conduits, ducts, pipes) and their means

of support through the wall, floor, ceiling or roof to prevent spread of fire and includes fire-resistive joint systems and through-penetration firestop systems.

- E. Through-penetration is an opening that passes entirely through a fire-resistance rated assembly.
- F. Through-penetration firestop system is a specific assembly of materials that are designed, tested and installed to prevent the spread of fire through openings in fire-resistive rated floors and walls to accommodate through-penetrations of electrical, mechanical, plumbing, and communications systems.
- G. "F" rating indicates the period of time that the through-penetration firestop system is capable of preventing the passage of flame to the unexposed (non-fire) side of the assembly in conjunction with an acceptable hose stream test performance.
- H. "T" rating indicates the period of time that the through-penetration firestop system is capable of preventing the passage of flame and temperature rise of 325 degrees F. above ambient temperature on the unexposed (non-fire) side of the assembly in conjunction with an acceptable hose stream test performance.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Shop Drawings: Submit manufacturer's illustrated shop drawings detailing materials, installation methods, and relationships to adjoining construction for each through-penetration firestop system and fire-resistant joint system, each construction condition and type of penetration or joint. Include firestop design designation from the approved testing agency (UL, for example).
 - 1. For those firestop applications for which no tested system is available from the manufacturer, the manufacturer's engineering judgment derived from similar tested system designs or other tests shall be submitted to the Authority Having Jurisdiction for their review and approval prior to installation.
- D. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- E. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. For those firestop applications that exist for which no approved tested system is available through a manufacturer, an engineered judgment derived from similar system designs or other approved tests shall be submitted to the local Authority Having Jurisdiction for review and approval prior to installation. Engineering judgment drawings shall follow requirements set forth by the International Firestop Council.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum ten years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this Section and:
 - 1. With minimum 3 years documented experience installing work of this type.
 - 2. Able to show at least 5 satisfactorily completed projects of comparable size and type.
- D. If the Contractor determines that individual trades (i.e. mechanical, plumbing, fire protection, electrical) shall be responsible for firestopping their penetrations, instead of all firestopping provided by a single contractor, products used shall be coordinated among the various trades

by the Contractor so that multiple products or manufacturers are not used for the same type of application.

1.07 MOCK-UP

- A. Install one firestopping assembly representative of each fire rating design required on project.
 - 1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.
 - 2. Where firestopping is intended to fill a linear opening, install minimum of 1 linear ft.
- B. Obtain approval of authority having jurisdiction before proceeding.
- C. If accepted, mock-up will represent minimum standard for the Work.
- D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.08 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 FIRESTOPPING - GENERAL REQUIREMENTS

- A. Firestop: All products shall be by one of the following acceptable manufacturers and shall be specific for each construction condition, fire-resistance requirement, and annular size. Multiple products shall not be used for the same application. Products shall include intumescent latex sealant, intumescent spray-applied coatings, fire-resistive elastomeric sealants, intumescent putty, intumescent wrap strips, job-mixed fire-resistive vinyl compound, mortar, and heat expanding pillows/bags.
- B. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- C. Manufacturers:
 - 1. A/D Fire Protection Systems Inc.
 - 2. 3M Fire Protection Products.
 - 3. Hilti, Inc.
 - 4. Nelson FireStop Products.
 - 5. Specified Technologies, Inc.
 - 6. Tremco.
 - 7. BioShield.
 - 8. Metacaulk - RectorSeal Corp
 - 9. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Firestopping Materials with Volatile Content: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- E. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.
- F. Fire Ratings: See Drawings for required systems and ratings.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use any system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of the floor assembly.

1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
 2. Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
 3. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
 4. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated.
- B. Head-of-Wall Firestopping at Joints Between Non-Rated Floor and Fire-Rated Wall: Use any system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.
1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
- C. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use any system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
 2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
 3. Watertightness: In addition, provide systems that have been tested to show W Rating as indicated.
- D. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
1. Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
 2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
 3. Watertightness: In addition, provide systems that have been tested to show W Rating as indicated.

2.03 FIRESTOPPING FOR FLOOR-TO-FLOOR, WALL-TO-FLOOR, AND WALL-TO-WALL JOINTS

- A. Concrete and Concrete Masonry Walls and Floors:
1. Floor to Floor Joints:
 - a. 2 Hour Construction: UL System FF-D-1013; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 2. Top of Wall Joints at Concrete/Concrete Masonry Wall to Concrete Over Metal Deck Floor:
 - a. 2 Hour Construction: UL System HW-D-0181; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 3. Concrete/Concrete Masonry Wall to Wall Joints:
 - a. 2 Hour Construction: UL System WW-D-0017; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
- B. Gypsum Board Walls:
1. Wall to Wall Joints:
 - a. 2 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
 - b. 1 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
 2. Top of Wall Joints at Underside of Steel Beam and Concrete Over Metal Deck Floor with Sprayed On Fireproofing:
 - a. 2 Hour Construction: UL System HW-D-0259; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 - b. 1 Hour Construction: UL System HW-D-0259; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 3. Top of Wall Joints at Concrete Over Metal Deck, Wall Parallel to Ribs:

- a. 2 Hour Construction: UL System HW-D-0184; Hilti CP 606 Flexible Firestop Sealant.
- b. 1 Hour Construction: UL System HW-D-0184; Hilti CP 606 Flexible Firestop Sealant.
4. Top of Wall Joints at Concrete Over Metal Deck, Wall Perpendicular to Ribs, Cut to Fit Ribs:
 - a. 2 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
 - b. 1 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
5. Top of Wall Joints at Concrete Over Metal Deck, Wall Perpendicular to Ribs, Not Cut to Fit:
 - a. 2 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
 - b. 1 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.

2.04 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

- A. Blank Openings:
 1. In Floors or Walls:
 - a. 2 Hour Construction: UL System C-AJ-0090; Hilti FS-ONE MAX Intumescent Firestop Sealant.
- B. Penetrations Through Floors or Walls By:
 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System C-AJ-8143; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-1226; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-2167; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 4. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System W-J-3198; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
 - b. 2 Hour Construction: UL System W-J-3199; Hilti CFS-SL SK Firestop Sleeve Kit.
 5. Cable Trays with Electrical Cables:
 - a. 2 Hour Construction: UL System C-AJ-4094; Hilti CFS-BL Firestop Block.
 6. Insulated Pipes:
 - a. 2 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE IMAX intumescent Firestop Sealant.
 7. HVAC Ducts, Uninsulated:
 - a. 2 Hour Construction: UL System C-AJ-7111; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.05 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

- A. Blank Openings:
 1. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
 2. 1 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
- B. Penetrations By:
 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System W-L-1389; Hilti FS-ONE Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System W-L-1389; Hilti FS-ONE Intumescent Firestop Sealant.
 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.

- b. 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.
4. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System W-L-3065; Hilti FS-ONE MAX Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
 - b. 1 Hour Construction: UL System W-L-3065; Hilti FS-ONE MAX Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
5. Cable Trays with Electrical Cables:
 - a. 2 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
 - b. 1 Hour Construction: UL System W-L-4011; Hilti CFS-BL Firestop Block.
6. Insulated Pipes:
 - a. 2 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System W-L-5028; Hilti FS-ONE MAX Intumescent Firestop Sealant.
7. HVAC Ducts, Insulated:
 - a. 2 Hour Construction: UL System W-L-7156; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System W-L-7156; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.06 FIRESTOPPING SYSTEMS

- A. Firestopping at Control Joints (without Penetrations): Any material meeting requirements.
- B. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- C. Elastomeric Silicone Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant; joint movement anticipated; conforming to the following:
 1. Elongation: +/- 40 percent of joint width.
 2. Products:
 - a. Fire Barrier Silicone 2000 by 3M Fire Protection Products.
 - b. CP601S by Hilti, Inc.
 - c. Biotherm 100 by BioFireShield.
 - d. Metacaulk 835+ by RectorSeal Inc.
- D. Latex Firestopping: Single component water-based latex compound and sealant; little or no joint movement anticipated, conforming to the following:
 1. Elongation: +/- 10 percent.
 2. Products:
 - a. Paintable Fire Barrier CP25WB + Caulk by 3M Fire Protection Products.
 - b. CP 606 by Hilti, Inc.
 - c. Metacaulk 1000 by RectorSeal Inc.
 - d. Biostop 500+ by BioFireShield.
- E. Spray-on Firestopping: Single component, water-based coating for sprayed-on applications, primarily head of wall joints, conforming to the following:
 1. Elongation: +/- 25 percent.
 2. Products:
 - a. FireDam Spray by 3M Fire Protection Products.

- b. CP 672 by Hilti, Inc.
 - c. Metacaulk 1100 by RectorSeal Inc.
 - d. Biostop 700 by BioFireShield.
- F. Foam Firestopping: Single component foam compound; conforming to the following:
- 1. Products:
 - a. RTV Foam by 3M Fire Protection Products
 - b. CP620 by Hilti, Inc
- G. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers; field mixed with water; conforming to the following:
- 1. Products:
 - a. CP636 Firestop Mortar by Hilti, Inc..
 - b. Fire Barrier Mortar by 3M..
 - c. Metacaulk Fire Rated Mortar by RectorSeal.
 - d. Bioshield K-10+ Mortar by BioFireShield.
- H. Fiber Firestopping Insulation (Safing Insulation): Mineral fiber batt, unfaced insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening; conforming to ASTM C 665 Type 1.
- 1. Density, ASTM D 1622: 4 lb/cu ft min.
 - 2. Max. Water Absorption, ASTM C 272: 0.1% by volume.
 - 3. Durability and Longevity: Permanent.
 - 4. Fire Resistance, ASTM E84: Flame spread: 15; Smoke Developed: 0.
 - 5. Manufacturer's "Z" impaling clips as required
 - 6. Product for Curtainwalls:
 - a. Foil faced Thermafiber Curtainwall Insulation by USG.
 - 7. Products:
 - a. Thermafiber by United States Gypsum Co.
 - b. Safing Insulation / MW by Owens Corning Insulation.
 - c. FBX Safing Insulation by Fibrex Insulations, Inc.
 - d. Safe by Roxul Inc.
- I. Firestop Devices - Wrap Type: Mechanical device with incombustible filler, intended to be installed after penetrating item has been installed; conforming to the following:
- 1. Products:
 - a. Duct Wrap, Collars, Plenum Wrap by 3M Fire Protection Products
 - b. Fire Barrier Cast-in Device by 3M Fire Protection Products
- J. Intumescent Putty: Compound that expands on exposure to surface heat gain; conforming to the following:
- 1. Products:
 - a. Moldable Putty by 3M Fire Protection Products.
 - b. Biostop Fire Rated Putty by BioFireShield.
- K. Reusable Firestopping: Removable intumescent compressible shapes, pillows, or blocks specifically tested in removable configuration; conforming to the following:
- 1. Products:
 - a. CP651 Cushions, CP657 Brick, CP658 Plugs by Hilti, Inc.
 - b. Metacaulk Pillows by RectorSeal.
 - c. Bio Firestop Pillows by BioFireShield.
 - d. 3M Fire Protection Products; Product Fire Barrier Pillows.
- L. Sleeves for through-penetrations shall be of non-combustible materials and securely fastened to the assembly penetrated.
- M. Identification Signage: Pressure sensitive self-adhesive, preprinted vinyl labels; including the following information on labels:
- 1. "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor's name, address, phone number.
3. Firestop system designation of applicable testing and inspecting agency (UL or WH).
4. Date of installation.
5. Firestop system manufacturer's name.
6. Installer's name.

PART 3 EXECUTION

3.01 CONDITIONS REQUIRING FIRESTOP MATERIALS

- A. General:
 1. Provide firestopping for conditions specified whether or not firestopping is indicated on the Drawings. It is intended that firestopping shall be provided at all fire-resistive assemblies and at all floor assemblies as required by applicable laws and codes.
 2. Insulation types specified in other Sections other than fiber firestopping insulation, shall not be installed in lieu of firestopping material specified herein, unless specified as a component of a tested fire-resistive joint assembly or a through-penetration firestop assembly.
- B. Building Exterior Perimeters:
 1. Where exterior facing construction passes continuously by the structural floor system creating a void between, provide firestopping equal to a minimum of two hours or the fire-resistance rating of the ceiling/floor assembly, whichever is greater per the firestopping manufacturer's tested assembly.
 2. Firestopping shall be provided whether or not there are any continuous or discontinuous clips, angles, plates, or other members bridging or interconnecting the facing and floor systems.
 3. Firestopping shall be provided at all joints and openings in and through-penetrations at exterior fire-resistive wall construction.
 4. Firestopping shall be provided where an exterior wall passes by perimeter structural members and the finish on the interior face of the wall does not continue up to close to the underside of the structural floor deck above, thus interrupting the fire-resistive integrity of the wall system. The space between the interior face of the wall and lower edge of the structural member shall be firestopped to continuously fill such open space.
- C. Interior Walls and Partitions:
 1. Provide firestopping at all voids between floor assemblies and walls or partitions extending continuously past the floor assembly (shafts, stairwells, etc.). Provide firestopping whether or not there are any clips, angles, plates or other members bridging or interconnecting the wall and floor systems, and whether or not such items are continuous.
 2. Provide firestopping at all voids where the top edge of a fire-resistant wall abuts decking.
 3. Provide firestopping at all construction joints, cracks, structural member penetrations, mechanical or electrical equipment penetrations, and any other openings in fire-resistant construction.
- D. Penetrations:
 1. Penetrations include sleeves, conduits, cables, wires, piping, ducts, expansion joints, structural members, or other elements that pass through one or both outer surfaces of fire-resistive floors, roofs, partitions, or walls, and all floor assemblies.
- E. Floors:
 1. Except for concrete slabs-on-grade, firestop all penetrations through floors in accordance with tested assemblies.
 2. Through-penetration firestop systems shall have "F" and "T" ratings of not less than 2-hour except that "T" ratings are not required at floor penetrations contained within a wall cavity and where such penetrations are not in contact with combustible materials.
 3. Provide firestopping to fill miscellaneous voids and openings in fire-resistant construction in a manner essentially the same as specified above.

3.02 EXAMINATION

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

3.03 PREPARATION

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

3.04 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Coordinate with mechanical, fire protection, electrical, and other trades to assure that all pipes, conduits, cable trays, cables, ducts, and other items that penetrate fire-resistant construction are properly firestopped.
- C. Install dams where recommended or required by tested fire-resistive joint assemblies and through-penetration firestop systems. Combustible damming material and other accessories not indicated as permanent components of firestop systems shall be removed after appropriate curing.
- D. Install firestopping materials in conjunction with fiber firestopping insulation (firesafing insulation) as required by tested assemblies.
- E. Where cable trays penetrate fire-resistant wall assemblies, provide pillow type firestop product. All cabling /wiring sleeves whether empty or utilized for wiring through fire-resistant assemblies shall be firestopped.
- F. Fire-resistive joint systems for control and expansion joints shall be capable of withstanding 50 percent movement in joint width existing at time of installation for both extension and compression.
- G. Do not cover installed firestopping until inspected by Authority Having Jurisdiction.
- H. Install labeling required by code.

3.05 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.06 IDENTIFICATION

- A. Identify all firestop system locations with pressure sensitive self-adhesive, preprinted vinyl labels.
 - 1. Attach labels permanently to both sides of penetrated construction surfaces and joints in fire-rated construction.
 - 2. Labels shall be visible to anyone seeking to disturb or remove penetrating items or firestop system. Where possible, labels shall be installed above finished ceilings. Where installed in exposed locations, labels shall be neatly located.
 - 3. Labels for horizontal joints shall be installed at a maximum spacing of twenty (20) feet.

3.07 FIELD QUALITY CONTROL

- A. Prepare and install firestopping systems in accordance with manufacturer's shop drawings, tested assemblies and instructions
 - 1. Follow safety procedures recommended in Material Safety Data Sheets.
 - 2. Finish all firestopping surfaces that are to remain exposed in the completed Work to a uniform and level condition.
- B. Firestopping materials and installations at joints and penetrations in fire-resistance rated assemblies and smoke barrier assemblies shall not be concealed from view until inspected and approved by the authority having jurisdiction. Such inspections shall not relieve the Contractor of responsibility for providing his own inspections and quality control in compliance with specified requirements.

- C. Inspections shall be performed as required by the building code, the Contract Documents or as otherwise directed by the Architect.
- D. The Contractor shall cooperate with individuals conducting such inspections. The Contractor shall notify inspectors at least five (5) days in advance of requested inspection date. All identification labeling, firestopping and smoke sealing work shall be completed prior to inspection.
- E. Any non-compliant materials shall be removed and replaced. Any locations missing required protection shall be corrected by the Contractor and re-inspected prior to concealing such areas with other construction. Any material or workmanship that is rejected shall be replaced promptly by the Contractor to the satisfaction of the inspector and/or Architect, and at no additional cost to the Owner.

3.08 PROTECTION

- A. Clean adjacent surfaces of firestopping materials. Leave work in a neat and clean condition.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 07 90 05
JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sealants and joint backing.
- B. Compressible fillers.
- C. Precompressed foam sealers.

1.02 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Firestop insulation.
- B. Section 07 84 00 - Firestopping: Firestopping sealants.
- C. Section 09 21 16 - Gypsum Board Assemblies: Acoustic construction.

1.03 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants; 2010.
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2012.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2013.
- E. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2010.
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with other Sections referencing this Section.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics.
- C. Samples: Submit samples 2 inch in size illustrating sealant colors for selection.
- D. Manufacturer's Installation Instructions: Indicate special procedures.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum twenty five years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this Section with minimum five years experience. Where applicable, applicators shall be approved by their respective material manufacturers as licensed applicators. All applicators shall be skilled personnel who are thoroughly trained and experienced in the necessary skills, completely familiar with the specific requirements of the Work.

1.07 MOCK-UPS AND SAMPLE INSTALLATIONS

- A. Mock-Up(s): Provide sealants for exterior wall mock-up(s) specified in Section 04 20 00 - Unit Masonry.
 - 1. Mock-up panel(s) shall demonstrate actual wall construction, detailing and workmanship.
 - 2. No work shall progress until the Architect has reviewed the mock-up panel(s). Panel(s) shall be revised as necessary to secure the Architect's acceptance and shall then become the standard of comparison for all related exterior wall work.

3. Mock-up panel(s) shall not be destroyed or moved until the Work is complete and accepted by the Architect. Upon completion of construction, mock-up panel(s) shall be removed.

1.08 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.
- B. Do not proceed with application of materials when surface or air temperatures are less than 40 degrees F or likely to drop to below 40 degrees F in the following 24 hours after sealant installation.
- C. Do not apply materials unless surface to receive coating is clean and dry, or if precipitation is imminent.
- D. Coordination: It shall be the responsibility of the Contractor to properly coordinate the Work of this Section with that of all other trades in order to ensure the providing of complete and continuous sealing and consistent use of products specified herein.

1.09 WARRANTY

- A. Warrantys:
 1. Include coverage for installed sealants and accessories which fail to achieve airtight seal and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.
 - a. Urethane Sealants: Five years.
 - b. Silicone Sealants: Twenty years, unless otherwise indicated with product description.
 2. Provide manufacturer's non-stain warranty.
- B. The installer shall provide an installation warranty that all Sealing shall be free of defects of materials and workmanship for two (2) years; and shall repair and/or replace such defective work, during the warranty term, without extra cost to the Owner.
 1. The following types of sealing failures will be considered defective Work: Leakage, loosening, loss of bond, hardening, cracking, crumbling, melting, shrinking, running, sagging, improper tooling, discoloration, or staining of adjacent work.

PART 2 PRODUCTS

2.01 SEALANTS

- A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.
 1. Color: To be selected by Architect from manufacturer's standard range.
 2. Applications: For minimal movement.
 - a. Interior wall and ceiling control joints.
 - b. Joints between door and window frames and wall surfaces, where minimal movement is expected and will receive field painting.
 - c. Interior sound sealing, non-fire rated smoke sealing where little movement is anticipated.
 - d. Other interior joints for which no other type of sealant is indicated.
 3. Note: Compatibility with materials sealant shall be in contact with shall be verified prior to use.
 4. Limitations: Not for use at joints subject to dynamic movement, submerged in water, and as otherwise limited by the manufacturer.
 5. Products:
 - a. Acrylic Latex 834 by Tremco Inc.
 - b. AC-20 + Silicone Acrylic Latex Caulking Compound by Pecora Corp.
 - c. Sherwin-Williams Company; 850A Acrylic Latex Caulk
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

- C. Interior Silicone Sealant: Silicone; ASTM C920, Uses I, M and A; single component, mildew resistant.
1. Color: As selected from the manufacturer's full color range.
 2. Applications: Sanitary
 - a. Joints between plumbing fixtures and floor and wall surfaces.
 - b. Joints between all countertops to splashes to wall surfaces.
 - c. Control, expansion, and corner joints within non-porous quarry and ceramic tile.
 - d. Joints between countertops and backsplashes when they are separate assemblies.
 3. Note: Compatibility with materials sealant shall be in contact with shall be verified prior to use.
 4. Limitations: Not for use at joints submerged in water, at porous materials like masonry, and as otherwise limited by the manufacturer.
 5. Products:
 - a. 786 Silicone Sealant by Dow Corning.
 - b. Pecora Corporation; 898NST Sanitary Silicone Sealant - Class 50.
 - c. Tremsil 200 by Tremco Global Sealants.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Interior Floor Joint Sealant: Polyurethane, self-leveling; ASTM C920, Grade P, Class 25, Uses T, M and A; single component.
1. Approved by manufacturer for wide joints up to 1-1/2 inches.
 2. Color: To be selected by Architect from manufacturer's standard range.
 3. Applications: Use for:
 - a. Expansion joints in floors.
 4. Products:
 - a. Tremco; Vulkem 455.
 - b. Pecora Corporation; NR-201 Self-Leveling Traffic and Loop Sealant.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Concrete Paving Joint Sealant: Polyurethane, self-leveling; ASTM C920, Class 25, Uses T, I, M and A; single component.
1. Color: Gray.
 2. Applications: Use for:
 - a. Joints in vehicular garage.
 3. Products:
 - a. Basis of Design: Pecora Corporation; NR-201 Self-Leveling Traffic and Loop Sealant
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Butyl Sealant: ASTM C1311; single component, solvent release, non-skinning, non-sagging.
1. Color: To be selected by Architect from manufacturer's standard range.
 2. Service Temperature Range: -13 to 180 degrees F.
 3. Applications: Use for:
 - a. Exterior thresholds.
 4. Products:
 - a. Bostik Inc
 - b. Pecora Corporation:
 - c. Tremco Global Sealants
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- G. General Purpose Exterior Sealant: Silicone, ASTM C920, Grade NS, Class 100/50, Uses T, NT, A, G, M, O; single component, neutral curing, non-sagging, non-staining, non-bleeding, ultra-low-modulus.
1. Color: To be selected by Architect from manufacturer's full range.
 2. Shore A Hardness Range: 15.
 3. Applications: High movement joints.
 - a. Control, expansion, and soft joints in stone, masonry, pre-cast concrete.
 - b. Joints between concrete and other materials.

- c. Joints between metal frames and other materials.
- d. Joints between dissimilar materials and building construction.
- e. Other exterior joints for which no other sealant is indicated.
4. Note: Compatibility with materials sealant shall be in contact with shall be verified prior to use.
5. Limitations: Not for use in structural applications, below grade or to materials that outgas, on brass, copper, or materials that can corrode, at joints continuously immersed in water, interior firestop sealing, at materials that bleed oils, plasticizers, or solvents, in confined spaces, to surfaces that will be painted, to surfaces in contact with food, to wet surfaces, to architectural finishes without prior testing, and as otherwise limited by the manufacturer.
6. Products:
 - a. Basis of Design: 790 by Dow Corning Corp.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ACCESSORIES

- A. Primer: Required, non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing (Exterior): Closed-cell polyethylene, non-bleeding neoprene or butyl rod, diameter approximately 30% greater than width of the joint, as recommended by the sealant manufacturer.
- D. Joint Backing (Interior): Open-cell polyurethane foam rod, diameter approximately 30% greater than width of the joint, as recommended by the sealant manufacturer.
- E. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
- F. Compressible Filler: Compressible, open-cell polyurethane foam saturated with stabilizing acrylics, with a waterproof sealing compound/release agent. Size appropriately to fill void geometry, as recommended by the sealant manufacturer.
 1. Products - general:
 - a. Polytite Standard by Polytite Manufacturing Corp.
 - b. Grayflex by Emseal Joint Systems Ltd., or as recommended by the sealant manufacturer.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Products - for secondary seal to sealant with joint backing:
 - a. Polytite B by Polytite Manufacturing Corp.
 - b. Backerseal by Emseal Joint Systems Ltd., or as recommended by the sealant manufacturer.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Notify the Contractor of conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected by the Contractor to meet acceptable industry standards in a manner acceptable to the Architect.
- C. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

- D. Protect elements surrounding the work of this section from damage or disfigurement. Mask off adjoining surfaces as needed to prevent surface damage.

3.03 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Sealing at Acoustical Construction: At construction designated "Acoustical Construction" seal around all joints and pipe, conduit, structural member, duct, and electrical box openings to gypsum wallboard or masonry as applicable. Seal bottom of gypsum wallboard partitions to floor slabs. Seal tops of masonry and gypsum wallboard partitions to decks (including voids at fluted decks), and seal sides of partitions to abutting construction. Note: Sealing related to installation of partition framing members and gypsum wallboard is specified under Section 09 21 16 - Gypsum Board Assemblies.
- E. Non-Fire Rated Smoke Sealing: At building assemblies identified as non-fire rated smoke barriers, seal all joints and pipe, conduit, structural member, duct and electrical box openings. Openings above finish ceilings or other concealed locations may be sealed on one side only. All openings and annular spaces shall be backed with fire safing insulation prior to installation of sealant.
- F. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer.
- G. Do not leave gaps between ends of joint backers. Do not twist, stretch or tear backers.
- H. Install bond breaker where joint backing is not used. Back rods shall be 25% wider than the joint width.
- I. Application of Sealant: Sealant shall be gun-applied through a nozzle opening of such diameter so that the full bead of sealant is gunned into the joint, filling the joint completely. A superficial or skin bead will not be acceptable.
 - 1. Sealant geometry (depth to width ratios) shall be as recommended by the manufacturer for each specific application.
 - 2. Beads shall be tooled immediately after application to ensure firm, full contact with the inner faces of the joint. Excess material shall be struck off with a tooling stick or knife.
 - 3. The finished bead shall be smooth, properly contoured and flush with the adjacent surface, or as otherwise indicated.
 - 4. Remove all excess materials and smears adjacent to the joint as work progresses. All materials shall be used in accordance with the manufacturer's printed instructions.
- J. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- K. Apply sealant when joint is cool to minimize chances of delamination and wrinkles.
- L. Tool joints concave.
- M. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.
- N. Fillers: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.
- O. Concrete Floor Joint Filler: Install concrete floor joint filler per manufacturer's written instructions. After floor joint filler is fully cured, shave joint filler flush with top of concrete slab.

3.04 FIELD QUALITY CONTROL

- A. Perform stain tests in accord with manufacturer's instructions and ASTM C1248 on mock-up joints prior to start of job installation.
- B. Perform adhesion tests in accord with manufacturer's instructions and ASTM C1193, Method A, Field Applied Sealant Joints Hand Pull Test.

1. Perform tests on mock-up joints prior to start of job installation.
 2. Perform a minimum of 1 test for every 200 linear feet of applied sealant and one (1) test per floor per building elevation minimum.
 3. For sealant applied to dissimilar materials, test both sides of the joint.
- C. Sealant failing test shall be removed, surfaces cleaned, resealed and retested.
- D. Maintain a test log and submit report to the Architect indicating tests, locations, dates, results and remedial action.

3.05 CLEANING

- A. Clean adjacent soiled surfaces.

3.06 PROTECTION

- A. Protect sealants until cured.

END OF SECTION

SECTION 07 95 13
EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion joint cover assemblies for wall, ceiling, and soffit surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - GYPSUM BOARD ASSEMBLIES: Placement of expansion joint assemblies in gypsum board walls and ceilings.
- B. Section 09 51 00 - Acoustical Ceilings: Ceiling grid expansion devices.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices and available colors and finish.
- C. Shop Drawings: Indicate joint and splice locations, miters, layout of the work, effected adjacent construction and anchorage locations.
- D. Samples: Submit two samples 6 inch long, illustrating profile, dimension, color, and finish selected.
- E. Manufacturer's Installation Instructions: Indicate rough-in sizes and required tolerances for item placement.

PART 2 PRODUCTS

2.01 EXPANSION JOINT COVER ASSEMBLIES

- A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled; designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke; suitable for traffic expected.
 - 1. Joint Dimensions and Configurations: As indicated on drawings.
 - 2. Joint Cover Sizes: Selected to suit joint width and configuration, based on manufacturer's published recommendations and limitations.
 - 3. Joint Movement Capability: If not indicated, provide minimum plus/minus 25 percent joint movement capability.
 - 4. Lengths: Provide covers in full lengths required; avoid splicing wherever possible.
 - 5. Anchors, Fasteners, and Fittings: Provided by cover manufacturer.
- B. Covers In Gypsum Board Assemblies: Provide style with anchoring wings that can be completely covered by joint compound.
- C. Covers In Fire Rated Assemblies: Provide cover assembly having fire rating equivalent to that of assembly into which it is installed.
 - 1. Acceptable Evaluation Agencies: UL, ULC, and Intertek.

2.02 MATERIALS

- A. Anchors and Fasteners: As recommended by cover manufacturer.
- B. Type 1: Exterior Walls:
 - 1. Product: Seismic Colorseal as manufactured by Emseal.
 - 2. Where indicated on the Drawings, seal at back-up construction with compressible filler.
 - 3. Finish: Color as selected by the Architect from manufacturer's full range.
- C. Type 2: Interior Walls and Gypsum Soffits / Ceilings; 2" joint for 1" movement.
 - 1. Product: FWS-200 and FWSC-200 as manufactured by CS Group.
 - 2. Where indicated on the Drawings, seal at back-up construction with compressible filler.

3. Finish: Factory finished, Kynar 500. Color as selected by the Architect from manufacturer's full range.
4. Provide RFX-2FW fire barrier and 2 mm SS foil for fire-rated locations.

2.03 FABRICATION

- A. Back paint components in contact with cementitious materials.
- B. Galvanize embedded ferrous metal anchors and fastening devices.
- C. Shop assemble components and package with anchors and fittings.
- D. Provide joint components in single length wherever practical. Minimize site splicing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joint preparation and dimensions are acceptable and in accordance with manufacturer's requirements.

3.02 INSTALLATION

- A. Install components and accessories in accordance with manufacturer's instructions.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent misalignment.

3.03 PROTECTION

- A. Provide strippable coating to protect finish surface.

END OF SECTION

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Steel doors and frames.
- B. Steel frames for wood doors.
- C. Steel frames (borrowed lites) for glazing.
- D. Decorative Steel Entry Doors and Frames.
- E. Thermally insulated steel doors.

1.02 RELATED REQUIREMENTS

- A. Section 08 14 16 – Flush Wood Doors: Wood doors to receive hollow metal frames.
- B. Section 08 16 13 – Fiberglass Doors: Pre-hung wood door frames.
- C. Section 08 71 00 - Door Hardware.
- D. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
- E. Division 26 - Electrical: Security system interface with doors and frames.

1.03 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2009.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2014.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2011.
- E. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
- F. ASTM C1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus; 2011.
- G. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- H. ASTM E1408 - Standard Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems; 1991 (Reapproved 2000).
- I. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames; 2014. (ANSI/BHMA A156.115)
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities; International Code Council; 2009 (ANSI).
- K. ITS - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- L. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2007.
- M. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2006.
- N. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.
- O. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association; 2012.
- P. UL - Building Materials Directory; Underwriters Laboratories Inc.; current edition.
- Q. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

- R. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- S. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.
- T. SDI 117: Manufacturing Tolerances for Standard Steel Doors and Frames.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, cores, sound ratings, profiles, anchorage and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, fire-ratings, glazing, frame profiles, anchors, and identifying location of different finishes, if any.
- D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum ten years documented experience.
- B. Maintain at the project site a copy of all reference standards dealing with installation.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with NAAMM HMMA 840. Store all materials upright, in a protected dry area, at least 1" or more off the ground or floor and at least 1/4" between individual pieces. Materials shall not be permitted to rust or corrode.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Steel Doors and Frames: (shall be a member of the Steel Door Institute)
 - 1. Ceco.
 - 2. Republic Doors
 - 3. Steelcraft.
 - 4. Curries Door Co.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Decorative Steel Entry Doors and Frames.
 - 1. Basis of Design: Masonite.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOORS AND FRAMES

- A. Requirements for All Doors and Frames:
 - 1. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 2. Door Top Closures: Welded, flush with top of faces and edges.
 - 3. Door Edge Profile: Beveled on both edges.
 - 4. Door Texture: Smooth faces.
 - 5. Glazed Lights: Non-removable stops on secure side; sizes and configurations as indicated on Drawings.
 - a. NOTE: Bottom of glazed lights must extend to within 43" of the floor and shall be at least 10" above the floor.
 - 6. Hardware Preparation: In accordance with DHI A115 Series, with reinforcement welded in place, in addition to other requirements specified in door grade standard.

7. Galvanizing for Units in Wet Areas: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653, with manufacturer's standard coating thickness
 8. Finish: Factory primed, for field finishing. Unless otherwise specified.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.
- C. Fire-Rated Door Assemblies:
1. All fire-rated doors and frames shall conform to and/or be tested by the requirements of:
 - a. UL 10C - Pressure Fire Test of Door Assemblies.
 - b. NFPA 252 - Methods of Fire Tests of Door Assemblies. 2003.
 - 1) After 5 minutes in the test, the neutral pressure level in furnace shall be established at 40 inches or less above the sill.
 - c. NFPA 80 - Standard for Fire Doors and Other Opening Protectives, 2007.
 - d. NFPA 101 - Life Safety Code, 2009.
 - e. International Building Code, 2009.
 - f. NFPA 105 - Standard for Installation of Smoke and Draft Control Assemblies, 2007.
 - g. ASTM E119 - Standard Method for Testing Construction Assemblies.
 - h. UL 1784: Smoke and draft control air leakage not to exceed 3.0 cu ft / min / sq ft of door opening at 0.10 inch of water for ambient and elevated temperature tests.
 2. All components of a fire-rated assembly (door, glazing, locks, closers, latches, lite frames, louvers, hinges, frames, etc.) shall be rated at or exceed the intended fire protection rating indicated for the assembly.
 3. Exit Enclosure Door Temperature Rise Rating: Max transmitted temperature of 450 degrees F. above ambient with 30 minutes of fire exposure, except for fully sprinkled buildings.
 4. Fire-rated doors and door frames shall be labeled in accordance with NFPA 80; permanently labeled and listed by UL, Intertek or Warnock Hersey.
 - a. Oversize fire-rated door assemblies: For door assemblies required to be fire-rated and exceeding sizes of tested assemblies, provide a certificate and label from an approved independent testing and inspection agency, indicating that the door and frame assembly conforms to the requirements of design, materials, and construction as established by individual listings for tested assemblies.
 - b. If any door or frame specified by the Architect to be fire-rated cannot qualify for appropriate labeling because of its design, hardware or any other reason, the Architect shall be so advised before proceeding with fabrication.
- D. Fire-Rated Window Assemblies: Comply with NFPA 80. Assemblies shall be identical to assemblies tested per NFPA 257 and shall be listed and labeled by UL, Intertek or Warnock Hersey.
- E. Fire-Rated Door, Door Frame and Window Assembly Ratings: As indicated on Door and Frame Schedule on the Drawings.

2.03 STEEL DOORS

- A. Exterior Doors:
1. Grade: ANSI/SDI A250.8 (SDI-100); Level 1 - Standard-Duty, Physical Performance Level C, Model 1 - Full Flush.
 2. Core: Polystyrene foam block, spanning the full thickness of the interior spaces of the door and securely attached to the faces using an epoxy glue.
 - a. Exception: Core for exterior fire-rated doors: non-asbestos mineral fiberboard.
 3. Thickness: 1-3/4 inch.
 4. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653, with A60/ZF180 coating.

5. Insulating Value, ASTM C1363: U-value of 0.50.
 6. Weatherstripping: Separate, see Section 08 71 00.
- B. Interior Doors, Non-Fire-Rated:
1. Grade: ANSI/SDI A250.8 (SDI-100); Level 1 - Standard-Duty, Physical Performance Level C, Model 1 - Full Flush.
 - a. Exception: Grade for all doors in frame openings over 72" wide: Level 4, physical performance Level A, Model 2, seamless.
 2. Core: Vertical steel stiffeners, minimum 20 gage and 8 " apart, securely attached to both face sheets by spot welds not more than 4" on center. Provide sound deadening batt type mineral wool between each stiffener for the full length of the door.
 3. Thickness: 1-3/4 inch.
 4. Finish: Factory primed, for field finishing, 1 mil minimum thickness.
- C. Interior Doors, Fire-Rated:
1. Grade: ANSI/SDI A250.8 (SDI-100); Level 1 - Standard-Duty, Physical Performance Level C, Model 1 - Full Flush.
 - a. Exception: Grade for all doors in frame openings over 72" wide: Level 4, physical performance Level A, Model 2, seamless.
 2. Fire Ratings: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure"). All fire-rated doors shall be smoke and draft control labeled.
 - a. Provide units listed and labeled by UL, WH, or other State of Maine approved testing laboratory.
 3. Core: Mineral board.
 4. Thickness: 1-3/4 inch.
 5. Finish: Factory primed, for field finishing.
 6. Smoke and Draft Control Doors (If not fire-rated, noted as "S" on the door schedule): Same construction as fire-rated doors with indicated fire rating, plus:
 - a. Maximum Air Leakage: 3.0 cfm/sq ft of door opening at 0.10 inch w.g. pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
 - b. Gasketing: No added gasketing or seals allowed.
 - c. Label: UL "S" label.
- D. Decorative Steel Entry Doors, Fire-Rated, interior use.
1. Applications: All public side corridor entry doors and other locations specified within the Drawings.
 2. 24-Gauge, galvanized steel faced door.
 3. Style: 2 Panel Square.
 4. Fire Ratings: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure"). All fire-rated doors shall be smoke and draft control labeled.
 - a. Provide units listed and labeled by UL, WH, or other State of Maine approved testing laboratory.
 5. Core: High-performance polyurethane foam with internal blocking and reinforcement.
 6. Thickness: 1-3/4 inch.
 7. Finish: Factory primed, for field finishing.
 8. Products: (Basis of Design) Masonite HD, Steel Edge by Masonite.
 9. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 STEEL FRAMES

- A. General:
1. Frames for Hollow Metal Doors:
 - a. ANSI A250.8 Level 2 Doors: 16 gage frames.
 - b. ANSI/SDI A250.8 (SDI-100), Level 2 and 3 Door Frames: 14 gage, 0.067 inch, minimum thickness.
 - c. ANSI A250.8 Level 4 Doors: 14 gage frames.
 2. Frames for Wood Doors:
 - a. Interior Opening 42 inches and less: 16 gage frames.

- b. Interior Openings exceeding 42 inches wide: 14 gage frames.
 - c. Exterior Openings: 14 gage frames.
 3. Finish: Same as for door.
 4. Provide minimum 16 gage mortar guard boxes at hardware cut-outs in frames for masonry walls and at strike reinforcement in frames for stud partitions.
 5. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units, unless detailed otherwise.
 6. Frames Wider than 48 Inches: Reinforce with steel channel, minimum 12 gage, factory welded to the frame head, flush with top. Such stiffeners shall not be used as lintels or load-carrying members.
- B. Exterior Door Frames: Fully welded.
1. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653, with A60/ZF180 coating.
 2. Finish: Factory primed, for field finishing.
 3. Thermally broken.
 4. Weatherstripping: Separate, see Section 08 71 00.
- C. Interior Door Frames, Non-Fire-Rated: Knockdown type.
1. Finish: Factory primed, for field finishing.
- D. Interior Door Frames, Fire-Rated: Knockdown type.
1. Fire Rating: Same as door, labeled.
 2. Finish: Factory primed, for field finishing.
- E. Decorative Steel Frame, Fire-Rated: Split jamb system type. Interior use.
1. Fire Rating: Same as door, labeled.
 2. Finish: Factory primed, for field finishing.
 3. Casing: TA-30 Colonial Steel Casing.
 4. Products: (Basis of Design) Fast-Frame by Timely (Masonite)
- F. Interior Frames for Glazing (Borrowed Lites): Construction and face dimensions to match door frames, and as indicated on Drawings.
- G. Corner joints shall be die mitered and have all contact edges closed tight and continuously welded.
- H. Frame, trim and profiles shall be as scheduled by the Architect and verified by the Contractor. All frame depths shall be coordinated with partition type depths by the Contractor. Frames for drywall partitions shall have 1/2 inch backbends with hooked profile.
- I. Minimum depth of stops shall be 5/8". Use 3/4" only where required for fire rating or security.
- J. When shipping limitations so dictate, frames for large openings shall be fabricated in sections designed for splicing in the field. All splicing locations and details shall be clearly identified on shop drawings.
- K. Frames for multiple or special openings shall have mullion and/or rail members that are closed tubular shapes having no visible seams or joints. All joints between faces of abutting members shall be securely welded and finished smooth.
- L. Frames shall be provided with supplemental internal concealed steel reinforcement, as engineered by the manufacturer.
- M. Floor Anchors: Shall be securely welded inside each jamb, with 2 holes provided at each jamb for floor anchorage. Where required adjustable floor anchors, providing not less than 2" height adjustment, shall be provided. Minimum thickness of floor anchors shall be 14 gage, zinc coated per ASTM A-591.
- N. Masonry Jamb Anchors: Frames for installation in masonry walls shall be provided with adjustable jamb anchors of the T-strap type, 16 gage minimum, zinc coated per ASTM A-591. Provide 3 anchors for frames up to 7'-6" high, 4 anchors for frames up to 8'-0" high and 1 additional anchor for each 2'-0" of height over 8'-0".

- O. Stud Partition Jamb Anchors: Shall be steel anchors, compatible with the actual stud used, minimum 18 gage thickness, zinc coated per ASTM A-591 Provide 4 anchors for frames up to 7'-6" high, 5 anchors for frames up to 8'-0" high and 1 additional anchor for each 2'-0" of height over 8'-0".

2.05 ACCESSORY MATERIALS

- A. Glazing: As specified in Section 08 80 00 - Glazing, field installed.
- B. Removable Stops: Rectangular, flush set, 18 gage galvanized, primed steel, butted corners; prepared for countersink style tamper proof screws.
- C. Fixed Stops: Custom full-flush with no apparent seams on the face of the door at the outside of spaces to be secured.
- D. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.
- E. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
- F. Temporary Frame Spreaders: Provide for all factory or shop-assembled frames.

2.06 FINISH MATERIALS

- A. Primer: Factory applied, rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.
- B. After fabrication, all tool marks and surface imperfections shall be dressed, permanently filled and sanded as required to make all faces and vertical edges smooth, level and free of all irregularities. Doors shall be primed to ensure maximum paint adhesion, on all exposed surfaces with a rust-inhibitive primer in accordance with ANSI A250 - Test Procedure and Acceptance Criteria for Primed Painted Steel Surfaces.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.02 INSTALLATION

- A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.
- B. Install fire-rated units in accordance with NFPA 80 and ASTM E119.
- C. Coordinate frame anchor placement with wall construction. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb, and anchors are securely attached. Verify that frames are square and plumb following removal of temporary spreaders.
- D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E. Coordinate installation of hardware in accordance with hardware manufacturer's templates and instructions. Doors and frames fabricated with hardware cutouts and reinforcing which will not properly accommodate finish hardware shall be rejected and replaced at no additional cost to the Owner.
- F. Coordinate installation of glazing.
- G. Coordinate installation of electrical connections to electrical hardware items.
- H. Immediately after erection, areas where prime coat or galvanizing has been damaged shall be sanded smooth and touch up with same primer or zinc rich rust-inhibitor primer as applied at the factory. Remove rust before touch-up is applied.

3.03 TOLERANCES

- A. Clearances Between Door and Frame:
1. Between steel doors and frame, at head and jambs: 1/8", with maximum 1/16" +/- variation.
 2. Between wood doors and frame, at head and jambs: 1/8" maximum.
 3. At door bottoms: 3/4" maximum
 4. At smoke-rated door bottoms: 3/8" maximum.
 5. Between meeting edges of pairs of doors: 1/8" maximum.
 6. Between face of door and stop: 1/8".
 7. Note: Door sills, except at fire-rated doors, may be undercut greater than the clearances indicated above if so scheduled on the Drawings and/or on the Door & Frame Schedule. Note sound-rated doors may require under-cuts less than maximums indicated above.
- B. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Protect installed doors, frames and accessories against damage from other construction work. Any damage prior to acceptance shall be repaired or replaced, if such action complies with the requirements and shows no evidence of repair or refinishing.

3.05 SCHEDULE

- A. Refer to Door and Frame Schedule on the Drawings.

END OF SECTION

SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors; flush and flush glazed configuration; fire rated and non-rated.
- B. Factory finishing of wood doors.

1.02 RELATED REQUIREMENTS

- A. Section 08 11 13 - Hollow Metal Doors and Frames.
- B. Section 08 71 00 - Door Hardware.
- C. Section 08 80 00 - Glazing: Site glazing of doors.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2014.
- B. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.
- C. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2013
- D. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association; 2012.
- E. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- F. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- G. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics. Submit manufacturer's certification of compliance with quality standards.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- D. Specimen warranty.
- E. Samples:
 - 1. Upon request, submit one sample of door construction, 8x8 inch in size cut from top corner of door and samples of lite frame section.
 - 2. Submit one full set of manufacturer's standard stain colors on specified veneer for selection.
 - 3. Submit two samples of door veneer, 6x6 inch in size illustrating selected wood grain, stain color, and sheen.
 - 4. Samples submitted and accepted shall serve to reflect the entire range of (color, texture, grain and sapwood/heartwood variation and shall be used as the standard for acceptance or rejection of installed materials.
- F. Manufacturer's certification that products are manufactured in the United States.
- G. Manufacturer's Installation Instructions: Indicate special installation instructions.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum ten years of documented experience.

- B. Fire Rated Door and Transom Panel Assemblies: Conform to the following standards for fire rated class as indicated.
 - 1. UL 10c UBC-10 Pressure Fire Test of Door Assemblies
 - 2. NFPA 252 Methods of Fire Tests of Door Assemblies
 - 3. NFPA 80 Standard for Fire Doors and Windows
 - 4. NFPA 101 Life Safety Code
 - 5. NFPA 105 Standard for Smoke and Draft Control Assemblies
 - 6. Fire & Smoke/Draft labeled and listed by Underwriters Laboratories or Warnock Hersey.
- C. All components of a fire-rated assembly (door, glazing, locks, closers, latches, lite frames, louvers, hinges, etc.) shall be rated at or exceed the intended fire protection rating indicated for the assembly.
 - 1. Temperature Rise Rating: At exit enclosures, provide doors that have a temperature rise rating of 450 degrees F maximum in 30 minutes of fire exposure.
 - 2. Pressure Test: After 5 minutes into the test, the neutral pressure level in furnace shall be established at 40 inches or less above the sill.
 - 3. Wood doors with fire rating requirements exceeding 20 minutes shall be Category A doors with integral intumescent strips.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials during transit, storage, and handling to prevent deterioration, damage and soiling. Package each door at the factory in a separate heavy sealed poly bag. Mark each bag at top and bottom of doors for location to correspond with opening number on the Drawings.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage. In the event of damage, immediately make all repairs and replacements necessary for approval of the Architect and at no additional cost to the Owner.
- C. Protect doors with resilient packaging. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation. Deliver door to job site only when building is dry and has reached average prevailing relative humidity of locality.
- D. Coordinate the work with door opening construction, door frame and door hardware installation. The Contractor shall take all measurements, make all investigations, and in general provide field work and coordination as required to ensure the proper fit of all Work specified herein. Doors and frames shall be sized, positioned and installed in accordance with the design intent represented on the Drawings. The design intent shall not be modified due to the Contractor's failure to provide coordination or obtain properly fabricated materials. Such coordination shall be provided sufficiently in advance so as to avoid delays in the construction schedule.

1.07 WARRANTY

- A. See Section 01 78 10 - Warranties for additional warranty requirements.
- B. Interior Doors: Provide a special manufacturer's warranty, signed by both the manufacturer, installer and Contractor, for the life of the installation.
- C. Include coverage for delamination of veneer, defective materials, telegraphing core construction, and warping. Unsatisfactory warpage shall be more than 1/4" in a 42" x 84" section and telegraphed core construction shall be defined as exceeding 0.01 inch in a 3 inch span. The warranty shall also include refinishing and reinstalling which may be required due to repair or replacement of defective doors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Graham Wood Doors.
 - 2. Eggers Industries.

3. Marshfield Door Systems, Inc.
4. Buell Door Co..
5. Algoma Hardwoods Inc.
6. Lambton.
7. VT Industries.
8. Mohawk Flush Doors.
9. Substitutions: See Section 01 60 00 - Product Requirements.

B. High Pressure Decorative Laminate Faced Doors:

2.02 DOORS

A. All Doors:

1. Quality Level: Premium Grade, in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, latest edition.
2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
3. High Pressure Decorative Laminate Faced Doors: 5-ply unless otherwise indicated.

B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.

1. Provide solid core doors at all locations.
2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with NFPA 252 or UL 10B - Negative (Neutral) Pressure; Underwriters Laboratories Inc. (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
3. Smoke and Draft Control Doors : All door assemblies shall be tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch w.g. pressure at both ambient and elevated temperatures; if necessary, provide additional gasketing or edge sealing.
4. Wood veneer facing for field opaque finish.

2.03 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.
- B. Fire-Rated Doors: Mineral core, Type FD, plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
1. 20 min Particle Core: AWI Type FD 1/3.
 2. Fire-rated Mineral Core C Label: AWI Type FD 3/4. Category A with integral intumescent strips. Fire-resistive particle board core C Label also allowed.
 3. Fire-rated Mineral Core B Label: AWI Type FD 1-1/2. Category A with integral intumescent strips.
 4. Cores for fire-rated doors shall be non-combustible mineral board, 30.8 to 34.7 pcf, containing no asbestos, as required for scheduled fire-resistance.
 5. Provide fire-rated pairs of doors with fire-retardant stiles of labeled and listed matching face veneer without formed steel edges and astragals.
- C. Doors scheduled to receive closers and /or exit devices shall have solid lumber rails, without compromising labeling or listing requirements. Thru-bolting of finish hardware shall not be permitted, unless specifically noted elsewhere in the Contract Documents.

2.04 DOOR FACINGS

- A. Veneer Facing for Opaque Finish: Medium density overlay (MDO).
- B. Facing Adhesive: Type I - waterproof.

2.05 ACCESSORIES

- A. Glazing: As specified in Section 08 80 00.
- B. Glazing Stops: Wood, of same species as door facing, mitered corners; prepared for concealed tamper proof fasteners at wood and countersunk oval head screws at metal frames. Fill fastener holes with color matching filler in the field.

1. Note: The bottom edge of all lites shall be at least 10 inches above the floor and not more than 43 inches above the floor.
- C. Astragals for Fire Rated Double Doors: Steel, T shaped, overlapping and recessed at face edge, specifically for double doors.

2.06 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 1. Provide solid blocks at lock edge and top of door for closer for hardware reinforcement.
 2. Provide solid blocking for other throughbolted hardware.
- C. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
- D. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- E. Factory machine doors for hardware to match existing conditions at existing door frames, subject to modifications during shop drawing review.
- F. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- G. Provide edge clearances in accordance with the quality standard specified.

2.07 FACTORY FINISHING - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS), Section 5 - Finishing for grade specified and as follows:
 1. Opaque: Factory primed, for field finishing.
- B. Factory finish doors in accordance with approved sample.
- C. Seal door top edge with color sealer to match door facing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine all doors before hanging and reject doors with defects.
- B. Verify existing conditions before starting work.
- C. Verify that opening sizes and tolerances are acceptable.
- D. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
- B. Install fire-rated doors in accordance with NFPA 80 requirements.
- A. Install smoke and draft control doors in accordance with NFPA 105 requirements.
- C. Field-Finished Doors: Trimming to fit is acceptable.
 1. Adjust width of non-rated doors by cutting equally on both jamb edges.
 2. Trim maximum of 3/4 inch off bottom edges.
 3. Trim fire-rated doors in strict compliance with fire rating limitations.
- D. Use machine tools to cut or drill for hardware.
- E. Coordinate installation of doors with installation of frames and hardware.
- F. Coordinate installation of glazing.

3.03 TOLERANCES

- A. Conform to specified quality standard for telegraphing, warp, and squareness.

- B. Edge Clearances shall be provided as follows:
1. Between wood doors and steel frames at heads and jambs: 1/8" maximum.
 2. At door bottoms: 3/4" maximum.
 3. Between meeting edges of pairs of doors: 1/8" max.
 4. Note: Doors that are not fire or smoke rated may be undercut greater than the clearances indicated above if so indicated on the Drawings and/or Door Schedule. Undercutting shall be performed as part of factory fabrication process to prevent excessive removal of bottom rail. Doors with sound-ratings may required undercut less than maximum indicated above.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.
- C. Align in frames for uniform clearance at each edge. Restore finish before installation if on-site fitting or machining is required. Replace or re-hang any doors which do not swing or operate freely, or are warped or twisted. Pre-finished doors damaged prior to acceptance shall be repaired or replaced. Doors may be prepared or refinished if work complies with requirements and show no evidence of repair or refinishing.

3.05 SCHEDULE

- A. Refer to Door and Frame Schedule on the Drawings.

END OF SECTION

SECTION 08 16 13
FIBERGLASS DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiberglass reinforced plastic (FRP) doors.
- B. Frames for fiberglass reinforced plastic doors.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware: Other door hardware.
- B. Section 09 91 23 - Interior Painting: Field finishing.

1.03 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2011.
- C. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2014.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Obtain hardware templates from hardware manufacturer prior to starting fabrication.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard details, installation instructions, and hardware and anchor recommendations.
- C. Shop Drawings: Show layout and profiles; include assembly methods.
 - 1. Indicate product components, including hardware reinforcement locations and preparations, accessories, finish colors, patterns, and textures.
 - 2. Indicate wall conditions, door and frame elevations, sections, materials, gages, finishes, location of door hardware by dimension, and details of openings; use same reference numbers indicated on Drawings to identify details and openings.
- D. Selection Samples: Submit two complete sets of color chips, illustrating manufacturer's available finishes, colors, and textures.
- E. Door Corner Sample: Submit corner cross sections, 10 inch by 10 inch in size, illustrating construction, finish, color, and texture.
- F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer; include detailed terms of warranty.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

- B. Store materials in original packaging, under cover, protected from exposure to harmful weather conditions and from direct contact with water.
 - 1. Store at temperature and humidity conditions recommended by manufacturer.
 - 2. Do not use non-vented plastic or canvas shelters.
 - 3. Immediately remove wet wrappers.
- C. Store in position recommended by manufacturer, elevated minimum 4 inches above grade, with minimum 1/4 inches space between doors.

1.08 FIELD CONDITIONS

- A. Do not install doors until structure is enclosed.
- B. Maintain temperature and humidity at manufacturer's recommended levels during and after installation of doors.

1.09 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Provide five (5) year manufacturer warranty covering materials and workmanship, including degradation or failure due to chemical contact.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Molded Fiberglass Doors:
 - 1. (Basis of Design) Commercial Series by Masonite.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOOR AND FRAME ASSEMBLIES

- A. Door and Frame Assemblies: Factory-fabricated, prepared and machined for hardware.
 - 1. Door and frame pre-assembled, complete with hinges; shipped with braces, spreaders, and packaging as required to prevent damage.
 - 2. Mechanical Durability: Tested to ANSI/SDI A250.4 Level A (1,000,000 cycles), minimum; tested with hardware and fasteners intended for use on project.
 - 3. Screw-Holding Capacity: Tested to 900 psi, minimum.
 - 4. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A; when tested in accordance with ASTM E84.
 - 5. Flammability: Self-extinguishing when tested in accordance with ASTM D635.
 - 6. Sizes: As indicated on drawings.
 - 7. Clearance Between Door and Frame: 1/8 inch, maximum.
 - 8. Clearance Between Meeting Stiles of Pairs of Doors: 1/8 inch, maximum.
 - 9. Clearance Between Bottom of Door and Finished Floor: 3/4 inch, maximum; not less than 1/4 inch clearance to threshold.
 - 10. Bottom Rail: Undercut and rail surface to be smooth 10 inches above finish floor, ADA compliance.

2.03 COMPONENTS

- A. Doors: Through-color gel coating on fiberglass reinforced polyester resin construction with reinforced core.
 - 1. Thickness: 1-3/4 inches, overall.
 - 2. Style: 2 Panel Square.
 - 3. Door Construction: Molded in one piece including gel coating on all sides; manufacturer's standard subframe, core and faces fused during cure in mold; hardware reinforcements
 - 4. Subframe and Reinforcements: Manufacturer's standard materials.
 - 5. Waterproof Integrity: All edges, cut-outs, and hardware preparations factory fabricated of fiberglass reinforced plastic; provide cut-outs with joints sealed independently of glazing or louver inserts or trim.

6. Hardware Preparations: Factory reinforce, machine, and prepare for all hardware including field installed items; provide solid blocking for each hardware item; make field cutting, drilling or tapping unnecessary; obtain manufacturer's templates for hardware preparations.
 7. Gel Coating: Ultraviolet stabilized polyester, marine grade NPG-isophthalic, with slightly textured semi-gloss final finish.
 8. Gel Coating Thickness: Minimum 15 mils wet, plus/minus 3 mils.
 9. Gel Coating Color: As selected by the Architect from the manufacturer's standard line of colors.
- B. Frames: Pre-hung wood frames with stops. Non-rated.
1. Width: See Drawings for wall types. Full width.
 2. Finish: Factory primed.
 3. Material: Clear pine.
- C. Hinge and Hardware Fasteners: Stainless steel, Type 304; wood screws.

2.04 ACCESSORIES

- A. Hardware: As specified in Section 08 71 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Set units plumb, level, and true-to-line, without warping or racking doors, and with specified clearances; anchor in place.
- C. Separate aluminum and other metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.

3.03 ADJUSTING

- A. Lubricate, test, and adjust doors to operate easily, free from warp, twist or distortion, and to fit watertight for entire perimeter.
- B. Adjust hardware for smooth and quiet operation.
- C. Adjust doors to fit snugly and close without sticking or binding.

3.04 CLEANING

- A. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

3.05 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 08 17 00
INTEGRATED DOOR OPENING ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Factory-assembled and factory-finished steel doors, frames, and hardware, for double-egress, cross-corridor pairs, and hold-open applications.

1.02 REFERENCE STANDARDS

- A. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2014.
- B. BHMA A156.3 - American National Standard for Exit Devices; 2014 (ANSI/BHMA A156.3).
- C. BHMA A156.4 - American National Standard for Door Controls - Closers; 2013 (ANSI/BHMA A156.4).
- D. BHMA A156.13 - American National Standard for Mortise Locks & Latches Series 1000; 2012 (ANSI/BHMA A156.13).
- E. BHMA A156.26 - American National Standard for Continuous Hinges; 2012 (ANSI/BHMA A156.26).
- F. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association; 2012.
- G. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
- D. Hardware Schedule: Detailed list of each hardware item to be provided on each door.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- B. Installer: Manufacturer certified, employed by supplier.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with manufacturer's instructions.
- B. Store in clean, dry ventilated space having controlled temperature and relative humidity between 30 and 60 percent.
- C. Stack doors flat and off the floor to prevent warping.

1.06 WARRANTY

- A. Provide manufacturer's standard warranty against defects in material and workmanship:
 - 1. For entire door opening assembly, provide two year warranty against defects in material and workmanship.
 - 2. For locksets, hanger rods, and panic exit devices, provide lifetime limited warranty.
 - 3. Warranty shall be void unless units are stored as recommended prior to installation.

PART 2 PRODUCTS

2.01 DOOR, FRAME, AND HARDWARE ASSEMBLIES

- A. Basis of Design:
 - 1. Total Door, Inc:
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Door, Frame, and Hardware Assemblies: Provide fully functional, factory-assembled and factory-finished door opening units, complete with door, frame, and hardware; complying with specified requirements.
- C. Performance Requirements: Comply with requirements of authority having jurisdiction, and the following:
 - 1. Force to Open and Close and Latch: Not more than 5 pounds to open or close latch and not more than 15 pounds to set door in motion.
 - 2. Fire Rating(s): As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure").
 - a. Provide units listed and labeled by ITS Warnock Hersey as a door and frame assembly.
 - b. Attach fire rating label to each fire rated unit.

2.02 COMPONENTS -- BASIS OF DESIGN

- A. Doors: Hollow metal doors complying with ANSI/SDI A250.8 (SDI-100) construction requirements and exceeding Performance Level A; electrogalvanized prior to finishing; manufacturer's standard core and reinforcements.
 - 1. Thickness: 1-3/4 inches.
 - 2. Fire-Rated Doors: 20 gage, 0.032 inch thick faces and edges.
- B. Door Frames: Formed steel cased opening (no stop required); electrogalvanized prior to finishing.
 - 1. Type: Prefinished; knock-down; for installation after wall finishes; 20 gage, 0.032 inch frame over 18 gage, 0.042 inch sub-buck.
 - 2. Provide frame anchors for secure installation and to comply with opening performance requirements.
- C. Factory Paint Finish: Two-part catalyzed polyurethane, low gloss, oven baked.
 - 1. Color(s): As selected from door manufacturer's full line; allow for one color.
- D. Hinges: Full height, formed steel, semi-concealed, dual pivot point, 180 degree swing; BHMA A156.26 Grade 1 with not less than 5,000,000 cycle testing; door manufacturer's standard paint finish; provide for all doors.
- E. Latch Stile: Full height, formed steel latch channel and concealed operating mechanism; door manufacturer's standard paint finish; provide for all doors.
 - 1. Mortise Locks/Latches: BHMA A156.13 Grade 1 with not less than 5,000,000 cycle testing.
 - 2. Locking/Latching Functions: To suit occupancy; to be selected from door manufacturer's standard functions.
 - 3. Pairs: Interlocking meeting stiles and strike on head of frame; foot strike only where indicated.
 - 4. Single Doors: Full height latch stop on frame jamb; top and bottom latch strikes.
- F. Door Closers - Concealed: Concealed overhead, cam-action track mounted in top of door; 135 degree swing, positive stop; adjustable sizing, latching, and closing speed; BHMA A156.4 Grade 1.
 - 1. Normally Open Doors: Entire closer including arm concealed when door is open.
 - 2. Provide for all fire-rated doors and other doors where indicated.
- G. Exit Devices: Flush panel type, recessed into door; extruded aluminum, natural anodized finish.

1. Projection From Face of Door: Maximum of 1/8 inch when door is open, minimum of 5/8 inch when closed.
 2. Complying with BHMA A156.3 with not less than 5,000,000 cycle testing.
 3. Face Insert: To match door finish.
 4. Provide for all doors unless otherwise indicated.
- H. Lever Trim: To operate manufacturer's standard locking/latching mechanism; lever design selected from door manufacturer's full line; rectangular escutcheon.
1. Material and Finish: Satin stainless steel.
- I. Electromagnetic Holders: Magnetic portion recessed into door; concealed power transfer device to frame, internal wiring; wall-mounted steel fixture and separate transformer.
1. Size: 1-3/8 inch diameter, 1/8 inch projection.
 2. Holding Force: 40 pounds-force.
 3. Wall Fixture Projection: 1/2 to 5-1/2 inches.
 4. Provide where doors are indicated to be NORMALLY-OPEN.
- J. Protection Plates: Full door width, bonded to door face and edges.
1. Material and Finish: Stainless steel, satin finished.
 2. Kick Plates: 6 inches high; no exposed fasteners.

2.03 ACCESSORY MATERIALS

- A. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's requirements and as necessary to achieve performance characteristics specified.
- B. Coordinate frame anchor placement with wall construction.
- C. Frames
1. Set plumb and square in accordance with DHI standards.
 - a. Out-of-square at frame head: Not to exceed 1/16 inch.
 - b. Out-of-plumb for each frame jamb: Not to exceed 1/16 inch.
 - c. Out-of-alignment for each side in plan: Not to exceed 1/16 inch.
 - d. Twist dimension: Not to exceed 1/16 inch.
 2. Brace until adjacent wall is constructed.
 3. Securely anchor to adjacent wall.
 4. Furnish and install clips, fastenings, and anchorages and conceal unless otherwise noted.
- D. Coordinate installation of electrical connections to electrical hardware items.
- E. Touch up damaged factory finishes.

3.03 TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.

END OF SECTION

SECTION 08 31 00
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall access door and frame units.
- B. Ceiling access door and frame units.
- C. It is not intended that the Drawings or Specifications identify specific access door sizes or locations. Subcontractors whose work requires access panels in wall, floor, and ceiling assemblies shall thoroughly examine all Contract Documents and provide suitable access to all equipment, hardware, accessories and all other items that may require adjustment, observation or maintenance. Note: Access doors located in mechanical equipment or ductwork are provided as part of the work of Division 23 - HVAC.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - Gypsum Board Assemblies: Openings in partitions and ceilings.
- B. Section 09 91 13 - Exterior Painting: Field paint finish.
- C. Division 22 - Plumbing
- D. Division 23 - HVAC
- E. Division 26 - Electrical

1.03 REFERENCE STANDARDS

- A. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- B. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide materials, construction, profiles, types, finishes, hardware, locking provisions, and details of adjoining work.

PART 2 PRODUCTS

2.01 WALL AND CEILING UNITS

- A. Manufacturers:
 - 1. Karp Associates, Inc
 - 2. Milcor.
 - 3. Nystrom Products.
 - 4. Larsens Manufacturing Co..
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies that units are to be installed in.
 - 1. Material: Steel.
 - 2. Style: Exposed frame with door surface flush with frame surface.
 - a. In Gypsum Board: Use drywall bead type frame.
 - b. In Masonry: Provide adjustable metal masonry anchors.
 - 3. Door Style: Single thickness with rolled or turned in edges.
 - 4. Door Style for separating heated from non-heated areas: Double wall with integral non-combustible insulation filler.
 - 5. Door Style for Fire-rated locations: double wall with integral non-combustible insulation filler.

6. Frames: 16 gage, 0.0598 inch, minimum.
7. Single Thickness Steel Door Panels: 1/16 inch, minimum.
8. Double-Skinned Hollow Steel Door Panels: 16 gage, 0.059 inch, minimum, on both sides and each edge.
9. Insulation: Non-combustible mineral or glass fiber.
10. Units in Fire Rated Assemblies: Fire rating as required by applicable code for the fire rated assembly that access doors are being installed.
 - a. Provide products listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated (labeled for horizontal or vertical installation).
11. Steel Finish: Primed.
12. Finish: Factory prime painted for field finish painting.
13. Size: As indicated on the drawings.
14. Hardware:
 - a. Hardware for Fire Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
 - c. Latch/Lock: Tamperproof tool-operated cam latch.
 - d. Inside Latch Release: For all doors intended to allow a person to fully pass through, provide Mechanism that allows the panel to be opened from the inside without the use of a tool or key
 - e. Gasketing: For all doors that separate heated and unheated space. Extruded neoprene, around the perimeter of the door panel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings for door and frame are correctly sized and located.
- B. Door locations that may physically or visually conflict with adjacent construction or building features shall be brought to the attention of the Architect prior to 'roughing-in'. Doors installed in locations objectionable to the Architect shall be removed, patched, and relocated at no additional cost to the Owner.

3.02 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings. Secure rigidly in place.
- C. Position units to provide convenient access to the concealed work requiring access.
- D. Adjust hardware and panels after installation for proper operation.
- E. Door lock keys shall be labeled and turned over to the Owner per Project Close-out requirements.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Overhead coiling doors, operating hardware, non-fire-rated and exterior, manual and electric operation.
- B. Wiring from electric circuit disconnect to operator to control station.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Support framing.
- B. Division 26 - Electrical: Power supply for operators.
- C. Section 26 27 17 - Equipment Wiring: Power to disconnect.

1.03 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.
- C. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated 600 2000 Volts; National Electrical Manufacturers Association; 2000 (R2008).
- D. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.04 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Overhead Coiling Doors:
 - 1. Basis of Design: Model 625 Stormtite Insulated Heavy Duty Rolling Door by Overhead Door Corp.
 - 2. Cornell Iron Works, Inc.
 - 3. The Cookson Company.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COILING DOORS

- A. Exterior Coiling Doors: Steel slat curtain.
 - 1. Coiling doors shall be capable of withstanding positive and negative wind loads in accordance with the following without undue deflection or damage to components:
 - a. Basic Wind Speed: 90 MPH.
 - b. Design Force per ASCE-7-05, Section 6.5.13.3.
 - 2. Sandwich slat construction with insulated core of foamed-in-place polyurethane insulation; minimum R-value of 7.7.
 - 3. Nominal Slat Size: 2-5/8 inches wide x required length.
 - 4. Finish: Factory painted, color as selected.
 - 5. Guides: Angles; galvanized steel.
 - 6. Hood Enclosure: Manufacturer's standard; galvanized steel.
 - 7. Electric operation.
 - 8. Weatherseals: Manufacturer standard, full width.

2.03 MATERIALS

- A. Curtain Construction: Interlocking slats.
 - 1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
 - 2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
 - 3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
- B. Steel Slats: ASTM A653/A653M galvanized steel sheet.
- C. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.
- D. Steel Guides: Formed from galvanized steel sheet, complying with ASTM A653/A653M.
 - 1. Galvanizing: Minimum G90/Z275 coating.
- E. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
- F. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.04 ELECTRIC OPERATION

- A. Operator, Controls, Actuators, and Safeties: Comply with UL 325; provide products listed by a testing agency acceptable to authorities having jurisdiction.
- B. Electric Operators:
 - 1. Basis of Design: Model RHX by Overhead Door Corp.
 - 2. Mounting: Wall mounted.
 - 3. Motor Rating: 1/2 hp; continuous duty.
 - 4. Motor Voltage: 115 volt, single phase, 60 Hz.
 - 5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
 - 6. Controller Enclosure: NEMA 250, Type 1.
 - 7. Opening Speed: 12 inches per second.
 - 8. Brake: Adjustable friction clutch type, activated by motor controller.
 - 9. Manual override in case of power failure.
- C. Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.
 - 1. 24 volt circuit.
- D. Infrared Transmitter/Receiver: Safety sensors capable of stopping or reversing the door operation. VITECTOR NEMA 4/4X OPTOEYE by Overhead Door Corp or equal.
- E. Transmitter: Built-in Radio Receiver System capable of storing up to 250 transmitters. Radio transmitters to be single button.
- F. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical service with Section 26 27 17.
- F. Complete wiring from disconnect to unit components.
- G. Install perimeter trim and closures.

3.03 TOLERANCES

- A. Maintain dimensional tolerances and alignment with adjacent work.
- B. Maximum Variation From Plumb: 1/16 inch.
- C. Maximum Variation From Level: 1/16 inch.
- D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING

- A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

- A. Clean installed components.

END OF SECTION

SECTION 08 35 13.23
FOLDING FIRE DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Horizontal sliding, accordion folding fire rated doors.
- B. Related construction.

1.02 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel Framing: Structural steel supports for door.
- B. Section 06 10 54 - Wood Blocking and Curbing: Wood blocking for track mounting.
- C. Section 09 21 16 - GYPSUM BOARD ASSEMBLIES: Fire rated gypsum board partition forming opening, track mounting, and storage pocket, if any.
- D. Section 09 91 23 - Interior Painting: Finish painting.
- E. Division 26 - Electrical: Power wiring to motor, control equipment and LCD door status displays.
- F. Division 28 - Electronic Safety and Security: Fire detection and alarm system connections for activating automatic closing operation.

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2012.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.
- D. UL 10B - Standard for Fire Tests of Door Assemblies; Underwriters Laboratories; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's technical literature; include UL listing data.
- C. Shop Drawings: Indicate construction and installation details and dimensions, including layout, electrical requirements, required stacking depth, height of header above finished floor; and requirements for anchorage and support of each door.
- D. Operation and Maintenance Data: Operating procedures, troubleshooting and repair methods, wiring diagrams, parts lists, and identification of authorized maintenance firms located in vicinity of project.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Approved by manufacturer; minimum five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the project site in manufacturer's original, unopened packaging, labeled to show name, brand and type.
- B. Store products in a protected dry location, in manufacturer's original packaging, in accordance with manufacturer's instructions.

1.07 WARRANTY

- A. See Section 01 78 10 - Warranties.

- B. Materials and installation shall be warranted against defects in workmanship for a period of one (1) year from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Accordion Folding Fire Doors:
 - 1. Basis of Design: Won-Door Corporation; Fireguard
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ACCORDION FIRE DOORS - GENERAL

- A. Provide self-closing fire doors of configurations indicated on the Drawings.
- B. Accordion Folding Fire Doors:
 - 1. 1-1/2 Hour FireGuard Cross Corridor FG90 by Won-Door Corp.
 - 2. 3 Hour FireGuard Cross Corridor FG180 by Won-Door Corp.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Fire Rating:
 - 1. Elevator - 2 hour fire rated: 90 minutes, with limited temperature rise; provide products listed and labeled by UL as a fire door under UL 10B.
 - 2. Fire Wall - 3 hour fire rated: 180 minutes, with limited temperature rise; provide products listed and labeled by UL as a fire door under UL 10B.
 - 3. Fire doors shall be capable of resisting an air pressure differential up to .05 inches of water column.
- D. Folding Fire Door Closing and Opening Operation: System shall be listed by UL in accordance with UL864 requirements and listed for use with door assembly in compliance with NFPA 80.
 - 1. Closing Operation: Automatic motor-operated closing upon activation by fire alarm system and by low battery charge.
 - a. Obstruction Detection: Contact with an obstruction causes the door to stop and pause before attempting to re-close.
 - b. Allow manual closing of door at any time.
 - 2. Opening Operation: Provide exit hardware on both sides of door.
 - a. When door has been automatically closed, operation of exit hardware shall open door at least 48 inches, width programmable up to full opening width; pause for 3 seconds, then automatically close.
- E. Configuration: Single; straight; recessed in pocket.
 - 1. Elevator A # 100:
 - a. Clear Opening Width: 66 inches.
 - b. Clear Opening Height: 90 inches.
 - c. Pocket Depth: 32 inches.
 - 2. Fire Wall # 141:
 - a. Clear Opening Width: 93 inches.
 - b. Clear Opening Height: 96 inches.
 - c. Pocket Depth: 32 inches.
 - 3. Striker Mounting: Recessed.

2.03 COMPONENTS

- A. Door Construction: Two parallel, accordion-type walls of panels independently suspended, 6 to 8 inches apart, with no pantographs or interconnections except at the lead-post.
 - 1. Panels: 24 gage, 0.0239 inch steel, V-grooved; connected by full height 24 gage (0.0239 inch) steel hinges.
 - 2. Insulation: Ceramic liner, 8 lb/cu ft.
 - 3. Lead Posts: 24 gage, 0.0239 inch cold rolled steel; internally mounted stabilizer bar; spring-loaded cap with PVC seals at top and bottom to fit into striker wall cavity; positive latching at striker wall.

4. Smoke and Draft Seals: Continuous PVC sweeps attached at top and bottom.
 5. Hanging Weight: 6.5 pounds per sq ft, maximum.
 6. Finish: All steel parts factory-applied enamel.
 7. Color: Manufacturer's standard gray.
- B. Suspension System: Two tracks, on 8 inch centers, attached to overhead structural support.
1. Tracks: 14 gage, 0.0747 inch cold rolled steel.
 2. Panel Hangers: Each panel individually suspended from a steel hanger pin and a 1/4 inch ball bearing roller.
 3. Lead Post Hangers: 8 wheel ball bearing trolley.
- C. Motor Operator Assembly: Chain drive attached to stabilizer bar trolley with DC gear-motor, drive sprocket and clutch.
- D. Power Supply: 12-volt maintenance-free DC battery, automatically maintained at capacity by continuous charger, 120 V AC.
- E. Controls: Microprocessor logic board, interconnect board, motor control relays, and limit switches; provide loud audible signal if sensors indicate high or low voltage, AC or DC; drive train, limit switch, or key switch malfunction; or ROM or RAM check-sum error.

2.04 RELATED CONSTRUCTION

- A. Track Support Construction: Provide supports attached to structure and mounting surface for tracks; comply with door manufacturer's instructions and recommendations.
- B. Pocket Construction: Provide pocket for concealment of accordion door when open; comply with door manufacturer's instructions and recommendations.
1. Pocket Door: Maintain full pocket clear width when pocket door is open.
 - a. Door: Solid core flush wood door with paint finish.
 - b. Frame: Hardwood, for paint finish; mounted flush with adjacent wall surface.
 - c. Hinges: Continuous type, solid brass; provide shaped hardwood bumper on inside of door as recommended by accordion door manufacturer.
 - d. Do not use positive latching type catches to hold door closed.
- C. Striker Recess: Mount striker in wall recess deep enough to prevent striker from protruding beyond face of wall; construct recess to maintain fire rating of wall.
- D. Access Door for Motor: 12 inches by 12 inches, 3 hour fire rated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that adjacent construction is suitable for installation of door.
- B. Verify that electrical utilities have been installed and are accessible.
- C. Verify access to, and proper clearance for, motor operators in wall cavity.
- D. Verify that door opening is plumb and header is level and of correct dimensions.
- E. Notify Architect of any unacceptable conditions or varying dimensions.
- F. Commencement of work indicates acceptance of substrate and opening.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions, shop drawings, and NFPA 80.
- B. Install fire doors plumb and level.
- C. Install wiring in accordance with applicable codes and NFPA 70.

3.03 ADJUSTING

- A. Adjust door installation to provide uniform clearances and smooth, quiet, non-binding operation.
- B. Test door closing functions under all anticipated conditions.

- C. Verify that all operations are functional and meet the requirements of the authorities having jurisdiction.

3.04 CLEANING

- A. Clean surfaces using manufacturer's recommended means and methods.

3.05 PROTECTION

- A. Protect installed work from damage.
- B. Repair or replace defective work prior to Substantial Completion.

END OF SECTION

SECTION 08 42 29
AUTOMATIC ENTRANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged power-operated door assemblies.
- B. Operators for doors provided in other Sections.
- C. Controllers, actuators and safety devices.
- D. Maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications.
- B. Section 06 10 54 - Wood Blocking and Curbing.
- C. Section 08 71 00 - Door Hardware: Other supplemental hardware for doors to receive automatic operators.
- D. Division 26 - Electrical

1.03 REFERENCE STANDARDS

- A. BHMA A156.10 - American National Standard for Power Operated Pedestrian Doors; Builders Hardware Manufacturers Association; 2011 (ANSI/BHMA A156.10).
- B. BHMA A156.19 - American National Standard for Power Assist and Low Energy Power Operated Doors; Builders Hardware Manufacturers Association; 2013 (ANSI/BHMA A156.19).
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
 - 2. Identify installation tolerances required, assembly conditions, routing of service lines and conduit, and locations of operating components and boxes.
- C. Product Data: Provide data on system components, sizes, features, locking system and finishes.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and manufacturer's hardware and component templates.
- E. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- F. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Wrenches and other tools required for maintenance of equipment.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section, with not less than fifteen years of documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of experience.
- D. The automatic entrance systems indicated on the Drawings and Specified herein shall be fully engineered by the manufacturer and certified to meet the requirements of all applicable codes and standards, and to be totally satisfactory for their intended purposes. Doors shall comply with the following standards:
 - 1. AAMA 101.
 - 2. ANSI Z97.1 Safety Glazing Materials Used in Buildings.
 - 3. ANSI A156.10 Power Operated Pedestrian Doors.
 - 4. ASTM B221 Aluminum Alloy Extruded Bars, Rods, Shapes, and Tubes.
 - 5. Aluminum Association Finishes Manual.
 - 6. UL 325 Electrical Door Systems.
 - 7. NFPA 101 Life Safety Code, 2009
 - 8. International Building Code, 2009.

1.06 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Provide two year manufacturer warranty.

PART 2 PRODUCTS

2.01 POWER OPERATED DOORS

- A. Power Operated Doors: Provide products that comply with the requirements of the authorities having jurisdiction; unless otherwise indicated, provide equipment selected for the actual weight of the doors and for light pedestrian traffic.
 - 1. Swinging Door Operators: Fully adjustable for opening and closing speeds, checking speeds, and hold-open time; in the event of power failure, disengage operator allowing door to function as a door with a spring closer.
 - 2. Exterior Swinging Doors: Provide equipment capable of operating, closing, and holding closed under positive and negative differential pressure; if necessary, provide power closing.
 - 3. Exterior and Vestibule Doors: Provide equipment suitable for operating temperature range of minus 20 to plus 140 degrees F ambient.
- B. Swinging Doors with Low-Energy Power Operators: Comply with BHMA A156.19; operator activated by pushing or pulling the door or by a manual actuator, not a sensor; safeties not required.
 - 1. Kinetic Energy of Door in Motion: 1.25 pound-foot, maximum.
 - 2. Force Required to Prevent Stopped Door From Opening or Closing: 15 pounds-force, maximum, measured at 1 inch from the latch edge of the door at any point in the swing cycle.
 - 3. Force Required to Release Latch, if Any, When Unpowered: 15 pounds-force, maximum, measured at 1 inch from the latch edge of the door at any point in the swing cycle.
 - 4. Force Required to Set Door in Motion When Unpowered: 30 pounds-force, maximum, measured at 1 inch from the latch edge of the door at any point in the closing cycle.
 - 5. Force Required to Fully Open Door When Unpowered: 15 pounds-force, maximum, measured at 1 inch from the latch edge of the door at any point in the closing cycle.

2.02 OPERATORS FOR SWINGING DOORS PROVIDED BY OTHERS

- A. Swinging Door Operator: Electric Surface mounted overhead. Provide for manual open and close operation of door leaves in the event of power failure with less than 50 lbs applied force to stile. ADA and ANSI 117.1 compliant.
 - 1. Operation: Power open, spring close operation.

2. Variable speed control for opening and closing cycles.
3. "Push" Side Actuator: Push plate.
4. "Pull" Side Actuator: Push plate.
5. "Pull" Side Safety: Door-mounted.
6. Hold Open: Toggle switch at inside head of doors; deactivate hold-open on activation of fire alarm system.
7. Electromagnetic Door shall fail safe due to failure, loss of power, activation of the fire alarm system or combination thereof.
8. Card reader equipment by Owner, shall interface with electromagnetic lock and auto operator.
9. Products:
 - a. HD Swing 4100 Series by Horton Automatics.
 - b. Gyro-Swing Power Operator GT500 by NABCO.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 CONTROLLERS, ACTUATORS, AND SAFETIES

- A. Controller: Provide microprocessor operated controller for each door.
- B. Comply with BHMA A156.10 for actuator and safety types and zones.
- C. Push Plate Actuator: Standard wall mounted, recessed momentary contact type; satin stainless steel plate; 4 inches diameter; labeled PUSH.
- D. Swinging Door Safety Device: Door-mounted proximity detector device arranged to prevent operation of door when persons or obstructions are in the swing zone.
- E. Fold Side Safety Sensor: Active infrared sensor shall utilize diffused technology. Sensor shall keep a closed door from opening or an open door from closing when the safety zone (fold zone) is occupied. When door is in open position, the fold side safety sensor shall provide threshold protection covering the full width of door overlapping into activating zone.

2.04 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electric Operators: The Contractor or electrical subcontractor shall furnish and install all wiring to operators. Provide 120 VAC, 60 cycle, single phase, 15 amp service to each operator on a separate circuit breaker routed into headers for swing and sliding doors and to jambs for folding doors.
- B. Motors: NEMA MG 1.
- C. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
- D. Disconnect Switch: Factory mount disconnect switch in control panel.

2.05 ACCESSORIES

- A. Steel Clips, Supports, and Steel Anchors: Galvanized to 1.25 oz/sq ft.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available and is of the correct characteristics.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. Provide for thermal expansion and contraction of door and frame units and live and dead loads that may be transmitted to operating equipment.
- C. Coordinate installation of components with related and adjacent work; level and plumb.

- D. Contact between aluminum and dissimilar materials shall be separated with neoprene isolation strips in compliance with AAMA 101 Dissimilar Materials Appendix, for prevention of electrolytic action and corrosion.
- E. Door installer shall coordinate his work with the installation of electrical conduit. See Electrical Drawings and Specifications.

3.03 ADJUSTING

- A. Adjust door equipment for correct function and smooth operation.

3.04 CLEANING

- A. Remove temporary protection, clean exposed surfaces.
- B. All items specified shall be cleaned on both inside and outside and shall be free of all mortar, plastic, paint and other foreign matter to prevent fouling of weathering surfaces, weatherstripping or the operation of hardware.
- C. After installation, all exposed portions of aluminum entrance work shall be adequately protected from damage.

3.05 CLOSEOUT ACTIVITIES

- A. Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.06 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of operating equipment for one year from Date of Substantial Completion, at no extra charge to Owner.

END OF SECTION

SECTION 08 43 13
ALUMINUM STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-Rated Aluminum-framed storefront, with vision glass. (Interior and Exterior Applications)
- B. Rated Aluminum-framed storefront, with vision glass. (Interior Application Only)
- C. Aluminum doors and frames.
- D. Weatherstripping.

1.02 RELATED REQUIREMENTS

- A. Section 07 25 00 - Weather Barriers: Sealing framing to weather barrier installed on adjacent construction.
- B. Section 07 84 00 - Firestopping: Firestop at system junction with structure.
- C. Section 07 90 05 - Joint Sealers: Perimeter sealant and back-up materials.
- D. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2012.
- B. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; American Architectural Manufacturers Association; 2009 (part of AAMA 501).
- C. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2013.
- D. ASTM A36 - Standard Specification for Carbon Structural Steel; 2008.
- E. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.
- G. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).
- H. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014.
- I. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).
- J. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Pre-installation Meeting: Conduct a pre-installation meeting at least two weeks before starting work of this Section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, internal drainage details and manufacturer's test data.

- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
- D. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- E. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
- F. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the State in which the Project is located.
- B. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.
- C. Installer's Qualifications: Company specializing in the installation and fabrication of aluminum glazing systems with a minimum of ten years of documented experience and approved by the manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Provide ten year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- C. Provide ten year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Non-Rated Storefront (Basis of Design): Series 402 NT by EFCO Corporation
 - 1. Acceptable Manufacturers:
 - a. C.R. Laurence Co., Inc; U.S. Aluminum.
 - b. Kawneer North America
 - c. YKK AP America Inc
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Rated Storefront (Basis of Design): SAFTIfire GPX Framing by SAFTIFIRST Fire Rated Glazing Solutions.
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
1. Glazing Rabbet (Exterior Applications): For 1 inch insulating glazing.
 2. Glazing Rabbet:
 - a. Non-Rated Applications: For 1/4 inch monolithic glazing.
 - b. Fire-Rated Applications: As required to accommodate rated glazing required by specified ratings.
 3. Glazing Position: Centered (front to back).
 4. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
 - a. Non-Rated Applications: 2 inches wide by 4-1/2 inches deep.
 - b. Fire-Rated Applications: 2-1/2 inches wide by 4 inches deep.
 5. Finish: Class II natural anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 6. Finish Color: As selected by Architect from manufacturer's standard line.
 7. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 8. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 9. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 10. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
 11. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 12. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
 13. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.
- B. Performance Requirements:
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Design Wind Speed: See Structural Drawings.
 - b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
 2. Water Penetration Resistance: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8.00 lbf/sq ft.
 3. Air Leakage: Maximum of 0.06 cu ft/min/sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 pounds per square foot pressure differential across assembly.
 4. Movement: Accommodate movement between storefront and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.
 5. Air Infiltration (Framing), ASTM E283: Limit air infiltration through assembly to 0.06 cu ft/min/sq ft of wall area, measured at 6.24 psf differential pressure across assembly.
 6. Air Infiltration (Entrance Doors), ASTM E283: Limit air infiltration through assembly to 1.0 cu ft/min/linear ft of crack length, measured at 1.56 psf differential pressure across assembly.

2.03 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.
 - 1. Framing members for interior applications need not be thermally broken.
 - 2. Glazing stops: Flush.
 - 3. Structurally Reinforced Members: Extruded aluminum with internal reinforcement of structural steel member.
- B. Glazing: As specified in Section 08 80 00.
- C. Doors: Glazed aluminum.
 - 1. Thickness: 1-3/4 inches.
 - 2. Top Rail: 3-1/2 inches wide.
 - 3. Vertical Stiles: 3-1/2 inches wide.
 - 4. Bottom Rail: 10 inches wide.
 - 5. Glazing Stops: Square.
 - 6. Finish: Same as storefront.
- D. Accessories: Fasteners, shims, brackets and other accessories for a complete installation of the storefront assembly.

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221.
- B. Structural Steel Sections: ASTM A36; galvanized in accordance with requirements of ASTM A123.
- C. Fasteners: Stainless steel.
- D. Perimeter Sealant:
 - 1. Non-Rated Applications: Type specified in Section 07 90 05.
 - 2. Rated Applications: Type specified in Section 07 84 00.
- E. Glass: As specified in Section 08 80 00.
- F. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- G. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

2.05 FINISHES

- A. High Performance Organic Coatings: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

2.06 HARDWARE

- A. Other Door Hardware: As specified in Section 08 71 00.
- B. Hinges: Butt type, ball bearing, NRP, 3 per leaf, swing clear; top and bottom.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.

- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- H. Install glass in accordance with Section 08 80 00, using glazing method required to achieve performance criteria.
- I. Install perimeter sealant in accordance with Section 07 90 05 and Section 07 84 00 as applicable.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.
- K. Door installer shall coordinate his work with the Work of Division 26 - Electrical, for complete concealment of internal raceways in door frames and strikes for security systems.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for independent testing and inspection requirements. Inspection will monitor quality of installation and glazing.
- B. Test installed storefront for water leakage in accordance with AAMA 501.2.

3.05 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.06 PROTECTION

- A. Protect installed products from damage during subsequent construction.

END OF SECTION

SECTION 08 44 13
GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed curtain wall, with vision glazing and glass infill panels.
- B. Perimeter transition system for curtain wall framing tie-in to building weather barrier system.
- C. Perimeter sealant.
- D. Firestopping between curtain wall and edge of floor slab.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Steel attachment devices.
- B. Section 07 25 00 - Weather Barriers: Sealing framing to weather barrier installed on adjacent construction.
- C. Section 07 84 00 - Firestopping: Firestop at system junction with structure.
- D. Section 07 90 05 - Joint Sealers: Perimeter sealant and back-up materials.
- E. Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; 2012.
- B. AAMA 501.1 - Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration Using Dynamic Pressure; 2005.
- C. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; 2009 (part of AAMA 501).
- D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
- E. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2013.
- F. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.
- G. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2011.
- H. ASTM A36 - Standard Specification for Carbon Structural Steel; 2008.
- I. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2012.
- J. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.
- K. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2006 (Reapproved 2011).
- L. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.
- M. ASTM C1135 - Standard Test Method for Determining Tensile Adhesion Properties of Structural Sealants; 2000 (Reapproved 2011).
- N. ASTM C1184 - Standard Specification for Structural Silicone Sealants; 2014.
- O. ASTM C1401 - Standard Guide for Structural Sealant Glazing; 2014.
- P. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).

- Q. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014.
- R. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Pre-installation Meeting: Conduct a pre-installation meeting at least 2 weeks before starting work of this Section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Submit curtainwall system product data including materials, component dimensions, describe components within assembly, anchorage and fasteners, glazing and infill, internal drainage details .
 - 2. Submit product data and installation details pertinent to job conditions for perimeter transition system.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
- D. Shop Drawings: Provide details of proposed structural sealant glazing (SSG) and weather sealant joints indicating dimensions, materials, bite, thicknesses, profile, and support framing.
- E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- F. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.
- G. Structural Glazing Adhesive: Submit product data and calculations showing compliance with performance requirements.
- H. Field Quality Control Submittals: Report of field testing for water leakage.
- I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the State in which the Project is located.
- B. Verify that each component is appropriate for use in structural sealant glazing (SSG) application in regards to at least the following properties; size, shape, dimensions, material, self-life, storage conditions, and color.
- C. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.
- D. Fabricator / Installer: Company specializing in the work of this Section with a minimum of ten years of documented experience and approved by the manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Correct defective Work within a two year period after Date of Substantial Completion.
- C. Provide ten year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide twenty year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design:
 - 1. EFCO ; Product 5600 Series
- B. Glazed Aluminum Curtain Wall:
 - 1. C.R. Laurence Co., Inc; U.S. Aluminum.
 - 2. YKK AP America Inc.
 - 3. Kawneer North America.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 CURTAIN WALL

- A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Outside glazed, with pressure plate and mullion cover, where indicated on drawings.
 - 2. Structural sealant glazing (SSG) adhesive on two (2)-sides, with temporary glazing stops, and pressure plate and mullion cover on 2-sides, where indicated on drawings.
 - 3. Glazing Method: Either shop/factory or field glazed system.
 - 4. Vertical Mullion Dimensions: 2-1/2 inches wide by 7-1/4 inches deep.
 - 5. Horizontal mullion snap covers: #5700, where indicated.
 - 6. Finish: High performance organic coatings.
 - a. Factory finish surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - c. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 - 7. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 8. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 9. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 10. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.
 - 11. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

2.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
 - 1. Design Wind Speed: See Structural Drawings.
 - 2. Seismic Loads: Design and size components to withstand seismic loads and sway displacement in accordance with the requirements of ASCE 7.
 - 3. Movement: Accommodate the following movement without damage to components or deterioration of seals:
 - a. Expansion and contraction caused by 180 degrees F surface temperature.
 - b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.
 - c. Movement of curtain wall relative to perimeter framing.
 - d. Deflection of structural support framing, under permanent and dynamic loads.
 - 4. Structural Sealant Glazing (SSG) System: For individual glass lites, design framing members to not exceed a deflection normal to the wall of L/175 between supports with 3/4 inch maximum, and a deflection parallel to the wall of L/360 with 1/8 inch maximum, whichever is less.
 - 5. Structural Glazing Adhesive: Limit working stress to 20 psi.
- B. Water Penetration Resistance: No uncontrolled water on indoor face when tested as follows:
 - 1. Test Pressure Differential: 15 lbf/sq ft.
 - 2. Test Method: AAMA 501.1.
- C. Air Leakage: Maximum of 0.06 cu ft/min/sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 pounds per square foot pressure differential across assembly.
- D. Thermal Performance Requirements:
 - 1. Condensation Resistance Factor of Framing: 70, minimum, measured in accordance with AAMA 1503.
 - 2. Overall U-value Including Glazing: 0.45 Btu/(hr sq ft deg F), maximum.

2.04 COMPONENTS

- A. Aluminum-Framed Curtain Wall: High performance, improved thermal break system, factory fabricated, factory finished aluminum framing members, and related flashings, anchorage and attachment devices.
- B. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 - 1. Structurally Reinforced Members: Extruded aluminum with internal reinforcement of structural steel member.
- C. Glazing: As specified in Section 08 80 00.

2.05 MATERIALS

- A. Extruded Aluminum: ASTM B221.
- B. Structural Steel Sections: ASTM A36; galvanized in accordance with requirements of ASTM A123.
- C. Structural Supporting Anchors Attached to Structural Steel: Design for bolted attachment.
- D. Fasteners: Stainless steel. Any exposed fasteners shall match curtainwall finish.
- E. Exposed Flashings: 0.032 inch thick aluminum sheet; finish to match framing members.
- F. Firestopping: As specified in Section 07 84 00.
- G. Structural Sealant Glazing (SSG) Adhesive: Neutral curing, silicone sealant formulated for SSG applications in compliance with ASTM C1184 and structural glazing industry guidelines, ASTM C1401.
 - 1. SSG adhesive in compliance with ASTM C920; Type S - Single-component, Grade NS, Class 50, Use NT, G, and A.

2. Ultimate Tensile Strength: Minimum of 50 psi as determined by test method ASTM C1135 under the following conditions.
 - a. Exposure to air temperatures of 190 degrees F and minus 20 degrees F.
 - b. Water immersion for seven (7) days, minimum.
 - c. Exposure to weathering for 5,000 hours, minimum.
 3. Sealant Design Tensile Strength: 20 psi, maximum.
 4. Hardness: 20 to 60 with Type A-2 durometer in compliance with test method ASTM C661.
 5. Tested for compatibility with glazing accessories and weatherseal sealant.
- H. Perimeter Sealant: As specified in Section 07 90 05.
- I. Glazing Gaskets: Special System 7500 Wall high thermal efficiency gaskets.
- J. Glazing Accessories: As specified in Section 08 80 00.
- K. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.
- L. Perimeter Transition System: Flexible system to transition between exterior aluminum curtainwall framing members and wall weather barrier system to maintain air, water and vapor seal. System includes dense translucent silicone transition panels, molded corners, extruded aluminum adaptors and silicone sealant for connection to aluminum framing, if required.
 1. Product: Tremco Proglaze ETA - System 3 typical or as details require.

2.06 FINISHES

- A. High Performance Organic Coatings: AAMA 2604; multiple coats, thermally cured fluoropolymer system.
- B. Color: To be selected by Architect from manufacturer's standard range.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other related work.
- B. Verify that curtain wall openings and adjoining air and vapor seal materials are ready to receive work of this section.
- C. Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

- A. Perimeter Transition System: Install the system in accordance with manufacturer's recommended practices. Note, a 3-D installation guide is available from the manufacturer.
 1. Install system aluminum extrusions to curtainwall framing if system does not engage into curtainwall framing glazing pocket.
 2. Install perimeter transition system panels and pre-fabricated corners into extrusions or glazing pockets, as applicable, and seal continuously with silicone sealant.
 3. Following installation of curtainwall framing, tie-in the transition system to the weather barrier on the perimeter blocking of openings per transition system manufacturer's recommendations in a full bead of silicone. Cut back panel widths as required to fit to adjacent blocking surfaces.
- B. Curtainwall Framing Installation:
 1. Install curtain wall system in accordance with manufacturer's instructions.
 2. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
 3. Provide alignment attachments and shims to permanently fasten system to building structure.
 4. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
 5. Provide thermal isolation where components penetrate or disrupt building insulation.

6. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
 7. Install firestopping at each floor slab edge.
 8. Install foamed-in insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- C. Pressure Plate Framing: Install glazing in accordance with Section 08 80 00, using glazing method required to achieve performance criteria.
 - D. Structural Sealant Glazing (SSG) Adhesive: Install structural sealant glazing adhesive and weatherseal sealant in accordance with manufacturer's instructions.
 - E. Install perimeter sealant in accordance with Section 07 90 05.
 - F. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.
- C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 FIELD QUALITY CONTROL

- A. Test installed curtain wall for water leakage in accordance with AAMA 501.2.
- B. Replace curtain wall components that have failed field testing and retest until performance is satisfactory.

3.05 ADJUSTING

- A. Adjust operating sash for smooth operation.

3.06 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.07 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 08 54 13
FIBERGLASS WINDOWS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Factory fabricated fiberglass windows with fixed and operating sash.
- B. Factory glazed including infill panels.
- C. Operating hardware.
- D. Insect screens.
- E. Perimeter sealant.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing.
- B. Section 07 25 00 - Weather Barriers.
- C. Section 07 90 05 - Joint Sealers: Perimeter sealant and back-up materials.

1.03 REFERENCE STANDARDS

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors; 2011.
- B. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
- C. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).
- D. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).
- E. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2000 (Reapproved 2008)

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Convene at least two weeks before starting work of this Section.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, anchors, fasteners, glass, and internal drainage details.
- C. Performance Validation: Provide specified performance validation before submitting shop drawings or starting fabrication.
- D. Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related work, installation requirements.
- E. Samples:
 - 1. Submit full range of finish samples for selection.
 - 2. Submit samples of operating hardware
- F. Grade Substantiation: Prior to submitting shop drawings or starting fabrication, submit one of the following showing compliance with specified grade:
 - 1. Evidence of AAMA Certification.
 - 2. Evidence of WDMA Certification.
 - 3. Evidence of CSA Certification.

4. Test report(s) by independent testing agency itemizing compliance and acceptable to authorities having jurisdiction.
- G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section, with not less than ten years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.
- B. Jig, brace, and box the window frame assemblies for transport to minimize flexing of members or joints.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F.
- B. Maintain this minimum temperature during and after installation of sealants.

1.09 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Provide ten year manufacturer warranty for insulated glass units from seal failure, interpane dusting or misting, and replacement of same. Include coverage for degradation of color finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fiberglass Windows:
 1. Basis of Design: Integrity Windows by Marvin Windows; Product All Ultrex.
 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 WINDOW UNITS

- A. Fiberglass Windows: Hollow, tubular, multi-layer fiber reinforced material; factory fabricated; with vision glass, related flashings, anchorage and attachment devices.
 1. Configuration: As indicated on drawings.
 2. Color: As selected by Architect from manufacturer's full range.
 3. Movement: Accommodate movement between window and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.
 4. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
- B. Performance Requirements: Provide products that comply with the following:
 1. Grade: AAMA/WDMA/CSA 101/I.S.2/A440 requirements for specific window type:
 - a. Performance Class (PC): R.
 2. Performance Validation: Windows shall comply with AAMA/WDMA/CSA 101/I.S.2/A440 performance requirements as indicated by having AAMA, WDMA, or CSA certified label, or an independent test report for indicated products itemizing compliance and acceptable by authorities having jurisdiction.
 3. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of window.
 - a. Design Wind Speed, Importance Factor and Exposure: See Structural Drawings.
 4. Design Pressure (DP): In accordance with applicable codes.

5. Deflection: Limit member deflection to 1/200 of the longer dimension with full recovery of glazing materials.
6. Assembly: To accommodate, without damage to components or deterioration of seals, movement between window and perimeter framing, deflection of lintel.
7. Air Infiltration: Limit air infiltration through assembly to less than 0.3 cu ft/min/sq ft of wall area, measured at a reference differential pressure across assembly of 1.57 psf as measured in accordance with ASTM E283.
8. Vapor Seal: No vapor seal failure at interior static pressure of 1 inch, 72 degrees F, and 40 percent relative humidity.
9. Water Leakage: None, when measured in accordance with ASTM E331.
10. System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to the exterior by a weep drainage network.
11. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound. Position thermal insulation on exterior surface of air barrier and vapor retarder.
12. Thermal Movement: Design sections to permit movement caused by thermal expansion and contraction of fiberglass to suit glass, infill, and perimeter opening construction.

2.03 COMPONENTS

- A. Frames: 3-3/32 inch wide x 1-3/8 inch deep profile.
 1. Type: Nailing flange (for new windows).
- B. Sash: 15/16 inch thickness.
- C. Jamb Extensions: 2 inch standard.
- D. Mullion(s): Interior and exterior mullion cover per manufacturer standards.
 1. Reinforcement: Steel plates and accessories as required per manufacturer design standards for applications and sizes indicated on the drawings.
- E. Insect Screens: Woven fiberglass mesh; 14/18 mesh size.
 1. Color: Charcoal.
- F. Weatherstripping: Single Hung: Foam filled vinyl bulb at sill; rigid vinyl with flexible seals at jambs and meeting rail; foam tape at stationary top sash. Awning: extruded foam filled bulb all sides at frame and PVC hollow extrusion on sash
- G. Operable Sash Weather Stripping: Wool pile; permanently resilient, profiled to effect weather seal.
- H. Fasteners: Stainless steel.

2.04 GLASS AND GLAZING MATERIALS

- A. Glass in Exterior Lights: Argon filled, Low E-180 Type, 11/16" thickness insulating panels, IGCC certified.

2.05 SEALANT MATERIALS

- A. Perimeter Sealant and Backing Materials: As specified in Section 07 90 05.
- B. Foam Insulation Sealant: As specified in Section 07 21 00.

2.06 HARDWARE

- A. Casement and Awning Sash: Zinc die-cast steel worm-gear operator with Painted finish.
 1. Jamb hinges with stainless steel track and injected molded hinge shoe and coated hinge arm. Single point lock at each jamb.
- B. Double and Single Hung Sash: Coil spring block and tackle balances; bottom sash tilt-in latch hardware; zinc die cast meeting rail cam-lock and keeper
- C. Finish For Exposed Hardware: Match window finish.

2.07 FABRICATION

- A. Fabricate framing, mullions and sash members with fusion welded corners and joints, in a rigid jig. Supplement frame sections with internal reinforcement where required for structural rigidity.
- B. Form sills in one piece. Slope sills for wash.
- C. Form snap-in glass stops, closure molds, weather stops, and flashings for tight fit into window frame section.
- D. Form weather stop flange to perimeter of unit.
- E. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- F. Arrange fasteners to be concealed from view.
- G. Permit internal drainage weep holes and channels to migrate moisture to exterior. Provide internal drainage of glazing spaces to exterior through weep holes.
- H. Assemble insect screen frame, miter and reinforced frame corners. Fit mesh taut into frame and secure. Fit frame with four spring loaded steel pin retainers.
- I. Double weatherstrip operable units.
- J. Factory glaze window units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- D. Provide thermal isolation where components penetrate or disrupt building insulation. Foam insulate in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

3.03 TOLERANCES

- A. Maximum Variation from Level or Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.

3.04 ADJUSTING

- A. Adjust hardware for smooth operation and secure weathertight closure.

3.05 CLEANING

- A. Remove protective material from pre-finished surfaces.
- B. Wash surfaces by method recommended and acceptable to window manufacturer; rinse and wipe surfaces clean.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hardware for wood and metal doors.
- B. Hardware for fire-rated doors.
- C. Electrically operated and controlled hardware.
- D. Lock cylinders for doors for which hardware is specified in other sections.
- E. Thresholds.
- F. Door gaskets.

1.02 RELATED REQUIREMENTS

- A. Section 08 11 13 - Hollow Metal Doors and Frames.
- B. Section 08 14 16 - Flush Wood Doors.
- C. Section 08 16 13 - Fiberglass Doors.
- D. Section 08 43 13 - Aluminum Storefronts: Hardware for doors in storefront, including:
- E. Section 08 44 13 - Glazed Aluminum Curtain Walls: Hardware for integral doors and frames except lock cylinders; installation of cylinders.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- C. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2009.
- D. BHMA A156.1 - American National Standard for Butts and Hinges; Builders Hardware Manufacturers Association, Inc.; 2013 (ANSI/BHMA A156.1).
- E. BHMA A156.4 - American National Standard for Door Controls - Closers; Builders Hardware Manufacturers Association, Inc.; 2013 (ANSI/BHMA A156.4).
- F. BHMA A156.6 - American National Standard for Architectural Door Trim; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.6).
- G. BHMA A156.7 - American National Standard for Template Hinge Dimensions; Builders Hardware Manufacturers Association; 2014 (ANSI/BHMA A156.7).
- H. BHMA A156.8 - American National Standard for Door Controls - Overhead Stops and Holders; Builders Hardware Manufacturers Association, Inc.; 2010 (ANSI/BHMA A156.8).
- I. BHMA A156.13 - American National Standard for Mortise Locks & Latches Series 1000; Builders Hardware Manufacturers Association; 2012 (ANSI/BHMA A156.13).
- J. BHMA A156.15 - American National Standard for Release Devices - Closer Holder, Electromagnetic and Electromechanical; Builders Hardware Manufacturers Association; 2011 (ANSI/BHMA A156.15).
- K. BHMA A156.18 - American National Standard for Materials and Finishes; Builders Hardware Manufacturers Association, Inc.; 2012 (ANSI/BHMA A156.18).
- L. BHMA A156.22 - American National Standard for Door Gasketing and Edge Seal Systems, Builders Hardware Manufacturers Association; 2012 (ANSI/BHMA A156.22).
- M. BHMA A156.23 - American National Standard for Electromagnetic Locks; Builders Hardware Manufacturers Association, Inc.; 2010 (ANSI/BHMA A156.23).

- N. 36 CFR 1191 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities; Final Rule; current edition; (ADAAG - Americans with Disabilities Act, Accessibility Guidelines).
- O. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; Door and Hardware Institute; 2004.
- P. DHI WDHS.3 - Recommended Locations for Architectural Hardware for Flush Wood Doors; Door and Hardware Institute; 1993; also in WDHS-1/WDHS-5 Series, 1996.
- Q. ICC A117.1 - Accessible and Usable Buildings and Facilities; International Code Council; 2009 (ANSI).
- R. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.
- S. NFPA 101 - Life Safety Code.
- T. NFPA 105 - Smoke and Draft Control Door Assemblies, latest edition.
- U. UL 10B - Fire Tests of Door Assemblies.
- V. UL 305 - Panic Hardware.
- W. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products onto which door hardware will be installed.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- C. Convey Owner's keying requirements to manufacturers.
- D. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this Section; require attendance by all affected installers.
- E. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements and Section 01 33 00, for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project.
 - 1. Name and manufacturer of each item, type, style, function, size and finish for each item.
 - 2. Door and frame sizes, thicknesses, materials, hand, degrees of opening for doors, with closers and/or overhead holders, and labeling.
 - 3. Explanation of all abbreviations, symbols, and codes used on schedules, and any other relevant information.
 - 4. The schedule shall be reviewed prior to submission by a certified Architectural Hardware Consultant (AHC).
- C. Samples:
 - 1. Upon request, submit 1 sample of hinge, latchset, lockset, and closer illustrating style, color, and finish.
 - 2. Approved samples will be incorporated into the Work, rejected samples will be returned to the contractor and shall be re-submitted.
- D. Hardware Schedule: Detailed listing of each item of hardware to be installed on each door. Use door numbering scheme as included in the Contract Documents. Identify electrically operated items and include power requirements.
- E. Keying Schedule: It shall be the responsibility of the hardware supplier to meet with the Owner to determine keying for the Project. submit separate detailed schedule, indicating clearly how

the Owner's final instructions on keying of locks has been fulfilled. As part of this meeting, the following shall be reviewed with the Owner:

1. Function of door, flow of traffic, degree of security required, lockset function and future expansion plans.
- F. Wiring Diagrams: Submit complete and detailed system operation and electrical diagrams specially developed for each opening requiring electrified hardware, except openings where only magnetic hold-opens or door position switches are specified.
- G. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- H. Close-out Documents:
1. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
 2. Catalog pages for each product, contact information for local representative for each manufacturer.
 3. As-installed hardware schedule, as-installed wiring diagrams and final keying schedule.
 4. All warranties and certification that electronic security hardware has been inspected and proper operation has been verified.
- I. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.
- J. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- K. Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Extra Lock Cylinders: One for each master keyed group.
 3. Tools: One set of all special wrenches or tools applicable to each different or special hardware component, whether supplied by the hardware component manufacturer or not.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum twenty years of documented experience.
- B. Hardware Supplier Qualifications: Company specializing in supplying commercial door hardware with ten years of experience.
- C. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this section.
- D. Electronic Security Hardware: The hardware supplier shall employ an individual knowledgeable in electrified components and systems who shall:
1. Produce wiring diagrams and consulting as needed,
 2. Coordinate installation of the electronic security hardware with related sub-contractors,
 3. Verify that all components are working properly upon completion of the electronic security hardware installation.
- E. Quantities: Furnish appropriate hardware for all doors in the Project. Approval of incomplete hardware schedule or acceptance of incorrect quantities at the job site will not alter this requirement. It is the intent of the hardware sets, indicated under Part 3 of this Section, to accurately list the hardware required for each door on this project. However, should any doors have been inadvertently omitted from the sets it will be the hardware suppliers responsibility to furnish hardware for these doors that is of the same quality, type, size, function, and finish as that specified for similar doors on the Project.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. All hardware shall be brought to the job site in the manufacturer's original packaging, with each hardware item individually labeled and identified with door opening code to match hardware schedule.

1.08 WARRANTY

- A. See Section 01 78 10 - Warranties, for additional warranty requirements.
- B. All finish hardware shall be warranted against manufacturing defects and faulty workmanship for a period of two years from the date of Substantial Completion, except for the following:
 - 1. Non-electronic door closers shall be warranted for ten years.
 - 2. Non-electrified exit devices shall be warranted for three years.
 - 3. Hinges shall be warranted for the life of the building.
 - 4. Continuous hinges shall be warranted for ten years.
- C. The hardware supplier, at his expense, shall adjust, repair, or replace, including labor for installation, any finish hardware supplied under this Section, which is found to be malfunctioning or defective during the above warrantee periods, except due to abuse.

PART 2 PRODUCTS

2.01 DOOR HARDWARE - GENERAL

- A. Provide hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.
- B. Provide items of a single type of the same model by the same manufacturer.
- C. Provide products that comply with the following:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. ANSI/ICC A117.1, American National Standard for Accessible and Usable Buildings and Facilities.
 - 4. NFPA 101, Life Safety Code.
 - 5. Fire-Rated Doors: NFPA 80.
 - 6. Hardware on Fire-Rated Doors, Except Hinges: Listed and classified by UL as suitable for the purpose specified and indicated.
 - 7. Hardware for Smoke and Draft Control Doors: Provide hardware that enables door assembly to comply with air leakage requirements of the applicable code.
 - 8. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.
- D. Electrically Operated and/or Controlled Hardware: Provide all power supplies, power transfer hinges, relays, and interfaces required for proper operation; provide wiring between hardware and control components and to building power connection.
- E. Finishes: Provide door hardware of the same finish unless otherwise indicated.
 - 1. In general, all hardware shall be US26D (satin chromium), unless noted otherwise.
 - 2. Exit devices, pulls, push plates, and kick plates shall be US32D (satin stainless steel).
 - 3. Closers shall be sprayed enamel or baked epoxy powder to match.
 - 4. Thresholds shall be mill finished aluminum.
 - 5. Continuous geared hinges shall be natural satin anodized.
 - 6. Gasketing shall be natural satin anodized aluminum.
- F. Fasteners:
 - 1. All hardware shall be installed with fasteners provided by the hardware manufacturer. Exposed fasteners shall be finished to match the hardware finish. Generally, fasteners for hardware shall be concealed when the door is closed.
 - 2. Closers shall not be thru-bolted except at high use/abuse locations as determined by the Architect.
 - 3. Mineral Core Wood Doors: Six bolts.
- G. Acceptable Manufacturers: Only hardware manufactured by one of the companies indicated below shall be accepted for use in the Project, and acceptance is limited only to the category of hardware for which the manufacturer is specified or listed as an acceptable equal.

2.02 HINGES

- A. Hinges: Provide hinges on every swinging door.
 - 1. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
 - 2. Provide ball-bearing hinges at all doors.
 - 3. Hinge pins shall be stainless steel at exterior doors; steel non-rising at interior doors.
 - 4. Provide hinges in the quantities indicated.
 - 5. Provide non-removable pins on exterior outswinging doors.
 - 6. Where electrified hardware is mounted in door leaf, provide power transfer hinges.
 - 7. Comply with BHMA A156.1 and A156.7; standard weight, 4-1/2" high, for doors up to 3 feet wide; heavy weight, 5" high, for doors over 3 feet wide.
 - 8. Provide hinge width of 4" or as required to clear surrounding trim. Provide long throw or clear swing hinges where frames are recessed in the wall and where greater than 110 degree swing is required.
 - 9. Materials: Interior hinges shall be steel.
- B. Quantity of Hinges Per Door:
 - 1. Doors From 60 inches High up to 90 inches High: Three hinges.
 - 2. Doors 90 inches High up to 120 inches High: Four hinges.
- C. Electric hinges shall be located at the second hinge from the bottom, or the nearest hinge to the electrified exit device. Provide sufficient number of concealed wires to accommodate electric function of the specified hardware.
- D. Basis of Design:
 - 1. Ives 5BB1 (up to 3 feet wide)
 - 2. Ives 5BB1HW (greater than 3 feet wide).
- E. Acceptable Manufacturers:
 - 1. Assa Abloy McKinney.
 - 2. Bommer Industries, Inc.
 - 3. C. R. Laurence Co., Inc.
 - 4. Stanley Hardware..
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 CONTINUOUS GEARED HINGES

- A. Continuous Geared Hinges: Heavy duty stainless steel or 6063-T6 aluminum alloy; split nylon bearings or stainless steel bearings at each hinge knuckle for quiet, smooth, self-lubricating operation. Hinges shall be capable of supporting door weights up to 600 pounds, and shall be successfully tested for 1,500,000 cycles. On fire-rated door assemblies, provide UL listed hinges. Install hinges with fasteners supplied by the manufacturer. Hole pattern shall be symmetrical.
- B. Basis of Design:
 - 1. Ives 224HD (mortised, full edge protection)
 - 2. Roton

2.04 PUSH/PULLS

- A. Push/Pulls: Comply with BHMA A156.6.
 - 1. Provide push and pull on doors not specified to have lockset, latchset, exit device, or auxiliary lock.
 - 2. On glazed storefront doors, provide matching push/pull bars on both faces.
- B. Plates: 0.050" thick, size as scheduled. Where door stile does not allow scheduled width, provide narrower plates.
- C. Bars: 3/4" diameter solid bar stock, projecting 2-1/2". Push bars shall extend to the center of each stile.
- D. Basis of Design:
 - 1. Ives 8200 Push, 8202 Pull, 3/4" round.

- E. Acceptable Manufacturers:
1. Assa Abloy McKinney..
 2. C. R. Laurence Co., Inc.
 3. Hager Companies.
 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 LOCKS AND LATCHES - GENERAL

- A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
1. Hardware Sets indicate locking functions required for each door.
 2. If no hardware set is indicated for a swinging door provide an office lockset.
 3. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
 4. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
- B. Keying: Grand master keyed.
1. Include construction keying.
 2. Construction Keying with Removable Core Cylinders: Include removal of construction cores and replacement with permanent key removable masterkeyed cores.
 3. Only exterior doors, doors to electrical, mechanical, high hazard areas and as deemed necessary by the Construction Manager for safety and/or security are required to be construction keyed.
 4. Supply keys in the following quantities:
 - a. 2 master keys.
 - b. 2 grand master keys.
 - c. 10 construction keys.
 - d. 3 control keys and 3 extra cylinder cores.
 - e. 3 change keys for each lock.
 5. When providing keying information, comply with DHI Handbook "Keying systems and nomenclature".
 6. Cylinder parts shall be constructed of brass, bronze, stainless steel or nickel silver. Keys shall be made from nickel silver.
 7. Factory key all cylinders with the manufacturer retaining permanent keying records. One biting list sent registered mail, confidential, shall be furnished for the Owner's use.
 8. The hardware supplier shall make himself available early in the submittal process for a meeting with the Owner to review lock functions and keying requirements for this Project.
 9. All keys shall be stamped with their respective key set number. Master keys shall be stamped with their respective master key set letters. Do not stamp any keys with the factory key change number. Do not stamp any cores with the key set on the face (front) of the core. Stamp identification on back or side of the cores.
- C. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

2.06 CYLINDERS

- A. Acceptable Manufacturers - Cylinders:
1. Schlage
 2. Sargent.

2.07 MORTISE LOCKSETS

- A. Mortise Locksets: ANSI A156.13, Grade 1, with case and parts manufactured from heavy gauge steel, zinc plated for corrosion resistance, with brass, bronze, or stainless steel armor plate.
1. Standard 2-3/4" backset with a full 3/4" throw, stainless steel latchbolt. Deadbolts shall be stainless steel with hardened steel rollers and shall have a full 1" throw.
 2. Lever trim shall be cast or forged with wrought roses. Levers shall be thru-bolted for proper alignment.

3. All doors opening into or from hazardous areas (loading platforms, mechanical, electrical, boiler and machine rooms, for example) shall have knurled or roughened levers for tactile warning to the visually impaired.
 4. Provide wrought boxes and strikes with proper lip length to protect trim but not to project more than 1/8 inch beyond trim, frame or inactive leaf.
 5. All lock functions shall be reviewed with the Owner during the keying meeting prior to ordering.
- B. Basis of Design:
1. Schlage L Series, The Standard Collection lever design.
- C. Acceptable Manufacturers:
1. Assa Abloy Sargent.
 2. Best Access Systems, division of Stanley Security Solutions.
 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 FLUSHBOLTS & COORDINATORS

- A. Automatic and Manual Flush Bolts: Forged bronze face plates, extruded brass levers, wrought brass guides and strikes; dust proof strikes.
1. Lever extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
 2. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
 3. Floor Bolts: Provide dustproof strike except at metal thresholds.
 4. Manual Flushbolts: Provide lever extensions for top bolt at over-size doors.
 5. Self-Latching Flushbolts: Automatically latch upon closing of door; manually retracted.
 6. Automatic Flushbolts: At labeled openings flushbolts to automatically latch upon closing of door; automatic retraction of bolts when active leaf is opened.
 7. Flush bolts for hollow metal doors: Extension rod type. Doors up to 7'-6" in height shall have 12" steel or brass rods; increase rod length by 6" for each additional 6" in door height.
 8. Flush bolts for wood doors: Corner wrap type.
- B. Coordinators: Provide on pairs of doors having closers and self-latching or automatic flushbolts, an astragal or other hardware that requires synchronized closing of doors provide a bar type coordinating device applied to the stop at the frame head.
1. Finish shall be shop primed, for field painting to match the door frame. Provide filler bars and brackets as required.
- C. Basis of Design:
1. Bolts: Ives FB358, FB31P, FB41P.
 2. Coordinators: Ives COR.
- D. Acceptable Manufacturers:
1. Assa Abloy McKinney.
 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.09 ELECTRIC STRIKES

- A. Electric Strikes: ANSI/BHMA A156.5, BHMA 501, Grade 1 compliant; UL listed for Burglary Resistance, and where required, shall be UL listed for use on fire-rated door assemblies.
1. Provide single unit, field adjustable, Fail-Safe or Fail-Secure operation as specified in the Hardware Schedule or as required by the Owner.
 2. Coordinate and provide frame preparations. Units shall be wired to the building security system by the Electrical Contractor.
 3. Finish shall match door hardware.
- B. Basis of Design:
1. Von Duprin 6211.
- C. Acceptable Manufacturers:

1. Assa Abloy HES.
2. Substitutions: See Section 01 60 00 - Product Requirements.

2.10 EXIT DEVICES

- A. Exit Devices: push-pad type, fabricated of brass, bronze, stainless steel, or aluminum, plated to match the architectural finish on the balance of the door hardware. All exit devices shall incorporate a fluid damper or other device to eliminate noise associated with device operation. The touch pad shall extend a minimum of one half of the door width. Only compression springs shall be used in devices, latches, and outside trims or controls. All devices shall incorporate a dead latching feature.
 1. Exit devices shall be UL listed panic exit hardware. All devices for fire rated openings shall be UL labeled fire exit hardware.
 2. Provide electric options as scheduled with all associated power units necessary for the proper operation of the device.
 3. All floor catches for vertical rod exit devices shall be recessed cup or dust proof type. Surface mounted catches shall be permitted only where required by code.
 4. Provide forged or cast heavy duty outside lever trim to closely match interior lockset lever design. Levers shall be vandal-resistant type that will travel to a 90 degree down position when more than 35 pounds of torque is applied and which can easily be re-set.
- B. Basis of Design:
 1. Von Duprin Rim Device: 35A..
- C. Acceptable Manufacturers:
 1. Assa Abloy Sargent.
 2. DORMA Group North America.
 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.11 ROLLER CATCHES

- A. Basis of Design:
 1. Ives RL32.

2.12 CLOSERS

- A. Closers: Comply with BHMA A156.4. Fully hydraulic rack and pinion action with a high strength cast iron 1-1/2" diameter cylinder and full cover. Hydraulic fluid shall not require seasonal closer adjustment for temperatures ranging from 120 to -30 degrees F. Hydraulic regulation shall be by tamper proof, non-critical valves.
 1. Provide surface-mounted, door-mounted closers unless otherwise indicated.
 2. Provide a door closer on every exterior door, mounted at inside face of door.
 3. Provide a door closer on every fire- and smoke-rated door. Spring hinges are not an acceptable self-closing device unless specifically so indicated.
 4. On pairs of swinging doors, if an overlapping astragal is present, provide coordinator to ensure the leaves close in proper order.
 5. At corridors, locate door-mounted closer on room side of door.
 6. Provide appropriate closers for doors required to swing 180 degrees.
 7. Sizing of closers: Unless otherwise indicated, comply with the manufacturer's closer sizing recommendations for door size, exposure to weather, and anticipated frequency of use.
 8. Closer Adjustment: Separate adjustment for latch speed, general speed, and backcheck; spring power shall be continuously adjustable over the full range of closer sizes and shall provide for reduced opening force for the physically challenged.
 9. The Contractor shall adjust closing and latching speeds of all closers as required to provide smooth, continuous closing action.
 10. Delayed Action: Provide ADA compliant delayed action option for all closers.
- B. Arms: Solid forged steel main arms and fore arms. All door closers shall be furnished with PARALLEL ARMS wherever possible and unless specified otherwise. In general, door closers shall be mounted on the "room" side of doors and shall not be visible in corridors, lobbies and other public spaces unless necessary.

1. Attachment Accessories: As required to properly attach the closer to the door and frame; including, but not limited to: drop plates, spacers, brackets and special arms.
- C. Basis of Design:
 1. LCN 4000 Series
- D. Acceptable Manufacturers:
 1. Assa Abloy Sargent.
 2. DORMA Group North America.
 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.13 STOPS

- A. Stops: Complying with BHMA A156.8; provide a stop for every swinging door, unless otherwise indicated.
 1. Provide wall stops, unless otherwise indicated or if field conditions do not allow for a wall stop. Concealed blocking for attachment to walls shall be provided under Section 06 10 00 or 06 10 54. If wall stops cannot be used, provide a floor mounted stop. It shall be the responsibility of the Contractor to properly coordinate stops to suit specific job conditions.
 2. If wall stops are not practical, due to configuration of room or furnishings, provide overhead stop.
 3. A stop is not required at doors with magnetic door holders. A positive stop feature of the door closer is not an acceptable substitute for a stop unless specifically indicated.
- B. Magnetic Holders: Comply with BHMA A156.15; with die cast housing; low profile, aluminum finish; fail safe; doors release to close automatically when electrical current is interrupted; holding force of minimum 35 pounds-force.
 1. Wall mounted holders as indicated or as required for optimal job conditions. Provide all necessary accessories to properly align and extend door holders to door or wall surfaces.
 2. Voltage: 120 V. Electrical Contractor shall wire holders via relay to building fire alarm system. A separate power supply from fire alarm system shall be provided.

2.14 GASKETING

- A. Gaskets: Comply with BHMA A156.22.
 1. Smoke Gaskets: On doors in smoke barriers, provide smoke gaskets at top, sides, and meeting rails of pairs, unless integral gasketing is provided with the doors. If fire/smoke partitions are not indicated on Drawings, provide smoke gaskets on each door identified as a "smoke door" and 20-minute rated fire doors.
 2. Weatherstripping: On each exterior door, provide weatherstripping gaskets, unless otherwise indicated at top, sides, and meeting rails of pairs.
 - a. Where exterior door is also required to have fire or smoke rating, provide gaskets functioning as both smoke and weather seals.
 - b. On each exterior door, provide door bottom sweep, unless otherwise indicated.
- B. Thresholds: Provide thresholds with barrier-free profiles.
 1. Thresholds shall be provided at each exterior door unless otherwise indicated.
 2. Set thresholds in a continuous bead of sealant.
 3. Threshold Fasteners: Non-ferrous solid brass or stainless steel screws.
- C. Basis of Design:
 1. Thresholds: Pemko 253.
 2. Weatherstrip: Pemko 315 Series, 45061 Series.
 3. Gasket: Pemko PK550
 4. Smoke Gasket: Pemko SFG45.
- D. Acceptable Manufacturers:
 1. Assa Abloy McKinney.
 2. Zero International, Inc.
 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.15 BIFOLDING DOOR HARDWARE

- A. Bifolding Door Hardware: Track, hanger fasteners, guides, and pulls; size track and hangers according to manufacturer's recommendations for weight of doors.
 - 1. Provide one pull for each pair of panels hinged together.
- B. Pocket Door Kits:
 - 1. Frame: 250 lb door capacity; steel channels and manufacturer's standard softwood species; depth as required for partition type; coordinate with door sizes as indicated in the Door Schedule. Note requirement for 84" high doors and 1575 adapter kit for 1-3/4" thickness doors. Frames to be field finished.
 - 2. Design Intent: Doors shall extent 4" into the opening when fully recessed in the pocket to expose accessible door pulls.
 - 3. Hardware: Complete track and carrier assembly.
 - 4. Basis of Design:
 - a. Pocket Door Kits: Johnson Hardware 2000 Series Pocket Door Frame.
 - b. Pocket Door Pulls (back-to-back): Hager 11E.
 - c. Pocket Door Lock: Johnson Hardware Privacy Pocket Door Lock.

2.16 PROTECTION PLATES AND ARCHITECTURAL TRIM

- A. Protection Plates:
 - 1. Material: 0.050" stainless steel, satin finish. Mount plates 1/2" above bottom of door; provide 4 beveled edges; screws shall match plates.
 - 2. Kickplates: 8" high x 2" less than width of door.
- B. Rain Drip Guard: Provide projecting drip guard over all exterior doors unless they are under a projecting roof or canopy.
- C. Silencers:
 - 1. Rubber plug-in type, not adhesive applied; 3 for each single frame, 2 for each paired door frame. All doors not scheduled to receive door stripping shall receive silencers.
- D. Basis of Design:
 - 1. Silencers: Ives.
- E. Acceptable Manufacturers - Protection Plates and Architectural Trim:
 - 1. Westware.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.17 KEY CONTROLS

- A. Key Management System: For each keyed lock on project, provide one set of consecutively numbered duplicate key tags with hanging hole and snap catch.
- B. Facility Manager's Key Cabinet: Sheet steel construction, piano hinged door with key lock.
 - 1. Mounting: Wall-mounted.
 - 2. Capacity: Actual quantity of keys, plus 25 percent additional capacity.
 - 3. Size key hooks to hold 6 keys each.
 - 4. Finish: Baked enamel, manufacturer's standard color.
 - 5. Key cabinet lock to building keying system.
 - 6. Set-up: Cabinet shall be set up fully cross-indexed, with hook numbers, key numbers, and description of times to which the key belongs. Provide electronic spread sheet key indexing for the Owner. Keys shall be tagged and ready to install in the cabinet.
 - 7. Installation: The key cabinet shall be installed in a location as directed by the Owner.
- C. Fire Department Secure Exterior Key Box:
 - 1. Key Box: Three (3) exterior mounted, U.L. listed, fully recessed, 5"h x 4"W x 3-1/4" D, high security key box. Verify location with Architect.
 - a. Product:
 - 1) Knox-Box as manufactured by Knox.
 - 2) Supra Fire Department Key Box as manufactured by Supra, or as otherwise required by the Fire Department.

- b. Color: Black
 - c. Tamper Switch: Fire alarm connected tamper switch for the key box, wiring provided by the Electric Contractor.
- D. Key Delivery:
- 1. All change keys, masters and grandmaster keys shall be shipped directly from the factory to the Owner registered mail, confidential.

2.18 CLEANING

- A. Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

2.19 PROTECTION

- A. Do not permit adjacent work to damage hardware or finish.

2.20 PREPARATION

- A. For steel doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Steel Doors and Frames."
 - 1. For steel doors and frames: See Section 08 11 13.
 - 2. Install hardware on fire-rated doors and frames in accordance with code and NFPA 80.
- B. Mounting heights for hardware from finished floor to center line of hardware item:
- C. Install hardware in accordance with manufacturer's instructions and applicable codes.
- D. Hardware shall only be installed by experienced finish hardware installers. Set units level, plumb and true to line and locations.
- E. Verify that electric power is available to power operated devices and of the correct characteristics.
- F. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.
- G. Lead-lined doors: Hardware penetrating lead-lined doors shall be lead wrapped. Levers and roses shall be lead lined. Apply kick and armor plates with 3M #1357 adhesive.

PART 3 EXECUTION

3.01 TEMPLATES

- A. Use templates provided by hardware item manufacturer.
- B. For wood doors: Comply with DHI "Recommended Locations for Architectural Hardware for Wood Flush Doors."

3.02 ADJUSTING AND INSPECTION

- A. Provide an Architectural Hardware Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.
- B. Adjust and check each item of hardware and each door, to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly as intended for the application. Adjust door control devices to operate smoothly after building HVAC systems are operational for compliance with opening force requirements of the ADA Guidelines.
- C. After the hardware has been installed, the hardware supplier shall inspect the Project and ascertain that all items of hardware have been properly installed, fastened, and are functioning as required. Any discrepancies shall be called to the attention of the Contractor, who shall be responsible for correcting them.
- D. Clean adjacent surfaces soiled by hardware installation. All hardware shall be protected from dents and scratches. Hardware that is damaged prior to building completion shall be replaced at no cost to the Owner.

- E. Instruct the Owner in the proper adjustment and maintenance of the hardware and finishes. Demonstrate the proper operation of all electronic hardware to the Owner.
- F. Approximately six months after the date of Substantial Completion, the installer and/or representatives of the latchset, lockset, panic device, closer and door control device hardware manufacturers shall return to the Project to perform the following work:
 - 1. Examine and re-adjust each item of door hardware as necessary to restore proper function.
 - 2. Consult with and instruct the Owner's personnel in recommended maintenance procedures.
 - 3. Replace hardware items that have deteriorated or failed due to faulty design, materials or installation of hardware units.
 - 4. Prepare a written report of current and predicable problems of substantial nature in the performance of the hardware.

END OF SECTION

SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass.
- B. Glazing compounds and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 90 05 - Joint Sealers: Sealant and back-up material.
- B. Section 08 11 13 - Hollow Metal Doors and Frames: Glazed doors and borrowed lites.
- C. Section 08 14 16 - Flush Wood Doors: Glazed doors.
- D. Section 08 43 13 - Aluminum-Framed Storefronts: Glazed framing and entrance doors.
- E. Section 08 44 13 - Glazed Aluminum Curtain Walls: Glazing framing.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; current edition.
- B. ANSI Z97.1 - Safety Glazing Materials Used in Buildings, Safety Performance Specifications and Methods of Test; 2010.
- C. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2011).
- D. ASTM C1036 - Standard Specification for Flat Glass; 2011e1.
- E. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2012.
- F. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2014.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2013.
- H. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2012a.
- I. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2010.
- J. GANA - GANA Glazing Manual; Glass Association of North America; 2009.
- K. GANA - GANA Sealant Manual; Glass Association of North America; 2008.
- L. SIGMA TM-3000 - Glazing Guidelines for Sealed Insulating Glass Units; 2004.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Convene a pre-installation meeting one week before starting work of this Section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
- C. Samples: Submit samples 8x8 inch in size of glass units.
- D. Certificates: Certify that products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA Glazing Manual and FGMA Sealant Manual for glazing installation methods.

- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum five years documented experience.
- C. All heat strengthened, tempered and laminated glass shall be permanently labeled by such means as etching, sandblasting, firing of ceramic materials on the glass, or by other suitable means so as to be easily visible and legible. The label shall identify the nominal thickness, glass type and compliance with requirements of ANSI Z97.1 and with a certification label of the Safety Glazing Certification Council (SGCC) or other certifying agency acceptable to the Authority Having Jurisdiction.
 - 1. Fire-protection-rated glazing shall be permanently labeled per IBC requirements with name of manufacturer, test standard and rating identification.

1.07 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 50 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.08 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Sealed Glass Units: Provide a ten (10) year warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same. The warranty shall ensure that coatings will not crack, flake, peel or otherwise fail or degrade.
- C. Laminated Glass: Provide a ten (10) year warranty to include coverage for delamination, including replacement of failed units.
- D. Firestop Glass: Provide a five (5) year warranty to include coverage for defective materials and workmanship for all firestop glass.

PART 2 PRODUCTS

2.01 INSULATING GLASS UNITS

- A. Type IG-1 - Sealed Insulating Glass Units: Vision glass, double glazed.
 - 1. Application: All exterior glazing unless otherwise indicated.
 - 2. Outboard Lite: Heat-strengthened float glass, or tempered glass where required by code or where indicated, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Low-E (passive type), on #2 surface.
 - 3. Inboard Lite: Annealed float glass or tempered glass where required by code or where indicated, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - 4. Total Thickness: 1 inch.
 - 5. Tempered Glass Applications: Provide this type of glazing in the following locations:
 - a. Glazed lites in exterior doors.
 - b. Glazed sidelights and panels next to doors.
 - c. Other locations required by applicable federal, State, and local codes and regulations.
 - d. Other locations indicated on the Drawings.
 - 6. Performance Requirements:
 - a. Visible Light Transmittance (VLT): 70%, nominal.
 - b. Winter U Value: 0.25 max.
 - c. Summer U Value: 0.25 max.
 - d. Light to Solar Gain Ratio (LSG): 1.85
 - e. Solar Heat Gain Coefficient (SHGC): 0.38 percent, nominal.
- B. Type IG-2 - Sealed Insulating Glass Units: Spandrel glazing.
 - 1. Application: Exterior glazing where indicated.

2. Outboard Lite: Heat-strengthened float glass and tempered glass where required by code or where indicated, 1/4 inch thick, minimum.
 - a. Coating: Same as on vision units, on #2 surface.
 3. Inboard Lite: Heat-strengthened float glass and tempered glass where required by code or where indicated, 1/4 inch thick.
 - a. Opacifier Color: To be selected by Architect from manufacturer standard, on #4 surface.
 4. Total Thickness: 1 inch.
 5. Safety (tempered) Glazing Applications: Provide this type of glazing in the following locations:
 - a. Glazed sidelights and panels next to doors.
 - b. Other locations required by applicable federal, State, and local codes and regulations.
 6. Other locations indicated on the Drawings.
- C. Type S-1 - Single Vision Glazing: Non-fire-rated, fully tempered.
1. Applications: All non-fire-rated interior glazing unless otherwise indicated.
 2. Types: Fully tempered.
 3. Tint: Clear.
 4. Thickness: 1/4 inch.
- D. Fire-Rated Safety Glazing:
1. Type S-2 - Fire-Rated Safety Glazing.
 2. Applications and IBC Fire Protection Ratings:
 - a. Glazed lites in fire doors at 2 hour fire barriers: D-H-T-90. T rating not required if sprinkled.
 - b. Glazed lites in fire doors at 2 hour exit enclosures: D-H-T-90. T rating not required if sprinkled.
 - c. Glazed lites in fire doors at 1 hour fire barriers: D-H-T-45 minimum. T rating not required if sprinkled.
 - d. Glazed lites in fire doors at 1 hour fire partitions and smoke barriers: D-NH-NT-20 minimum.
 - e. Glazed fire windows, borrowed lites, sidelights, transom lites in 1 hour fire barriers, smoke partitions and fire partitions: OH-45
 3. Fire Protection Ratings: As indicated on the Drawings.
 4. Thickness: As required to meet rating requirements, thin profile.
 5. Fire Window Frames: Fire-rated hollow metal. See Section 08 43 13.
 - a. Glazing Thickness: 7/8 inch, thin profile.
 6. Glazing Method: As required for fire rating.
- E. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
1. Application: Locations indicated on the Drawings.
 2. Thickness: 1/4 inch
 3. Edge (at frameless locations): Beveled, polished.

2.02 EXTERIOR GLAZING ASSEMBLIES

- A. Structural Design Criteria: Select type and thickness to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with International Building code, 2009 edition.
1. Design Pressure: Calculated in accordance with applicable codes.
 2. Design Wind Speed: See Structural Drawings.
 3. Use the procedure specified in ASTM E1300 to determine glass type and thickness.
 4. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
 5. Glass thicknesses listed are minimum.

- B. Thermal and Optical Performance: Provide glass products with performance properties specified above. Performance properties shall be manufacturer's published data as determined according to the following procedures:
 - 1. Center of glass U-Value: NFRC 100 methodology using LBNL WINDOW 5.2 computer program.
 - 2. Center of glass solar heat gain coefficient: NFRC 200 methodology using LBNL-35298 WINDOW 5.2 computer program.
 - 3. Solar optical properties: NFRC 300.
- C. Insulating Glass shall comply with ASTM D 2190 Standard Specification for Insulating Glass Unit Performance and Evaluation. Unit shall be certified for compliance by the IGCC.
- D. Unit Overall Thickness Tolerance: - 1/16" / + 1/132".
- E. Comply with ASTM E546 Standard Test Method for Frost Point of Sealed Insulating Glass Units and ASTM E576 for insulating glass units in the vertical position.
- F. Insulating glass units shall be double sealed with a primary seal of polyisobutylene and a secondary seal of silicone.
 - 1. Minimum thickness of secondary seal: 1/16".
 - 2. Target width of primary seal: 5/32".
 - 3. No primary seal voids or skips allowed.
 - 4. Gaps or skips between the primary and secondary sealants are permitted to a maximum width of 1/16" by maximum length of 2" with gaps separated by at least 18". Continuous contact between the primary seal and the secondary seal shall be provided.
 - 5. Primary and secondary sealant adhesion shall exhibit continuous, tenacious adhesion to both glass and spacer contact areas.
- G. Lite spacer shall be aluminum with three bent corners and one keyed-soldered corner or four bent corners and one straight butyl injected zinc plated steel straight key joint to provide a hermetically sealed and dehydrated space.
- H. Edge Seal Construction: Structural aluminum with formulated polyurethane thermal barrier, for no direct heat flow path. Warm Edge IG Spacer as manufactured by Technoform., or equal.
- I. Air and Vapor Seals: Provide completed assemblies that maintain continuity of building enclosure vapor retarder and air barrier:
 - 1. In conjunction with vapor retarder and joint sealer materials described in other Sections.
 - 2. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

2.03 GLASS MATERIALS

- A. Float Glass Manufacturers:
 - 1. AGC Flat Glass North America, Inc.
 - 2. Guardian Industries Corp.
 - 3. Pilkington North America Inc.
 - 4. PPG Industries, Inc.
 - 5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Float Glass: All glazing shall be float glass unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).
 - 2. Heat-Strengthened and Fully Tempered Types: ASTM C1048.
 - 3. Tinted Types: Color and performance characteristics as indicated.
 - 4. Thicknesses: As indicated; for exterior glazing comply with specified requirements for wind load design regardless of specified thickness.
- C. Fire-Resistance-Rated Glazing: Type, thickness (thin profile), and configuration as required to achieve indicated ratings.
 - 1. Provide products listed by Underwriters Laboratories or Intertek Warnock Hersey.
 - 2. Safety Certification: 16 CFR 1201 Category II.

3. Products:
 - a. SAFTI FIRST; SuperLite II-XL.
 - b. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.04 SEALED INSULATING GLASS UNITS

- A. Manufacturers:
 1. Any of the manufacturers specified for float glass.
 2. Basis of Design: SunGuard SuperNeutral 68 by Guardian Industries Corp.
 3. Substitutions: Refer to Section 01 60 00 - Product Requirements.
- B. Sealed Insulating Glass Units: Types as indicated.
 1. Application: Exterior, except as otherwise indicated.
 2. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 3. Edge Spacers: Aluminum, bent and soldered corners.
 4. Edge Seal: Glass to elastomer with supplementary silicone sealant.
 5. Purge interpane space with dry hermetic air.

2.05 GLAZING ACCESSORIES

- A. Glazing Materials: Select glazing compounds, sealants, tapes, gaskets and additional glazing materials of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.

2.06 INTERIOR SLIDING GLASS UNITS

- A. Interior Sliding Glass Units: Assembly includes fixed and sliding window panels with 1/4" clear tempered glass with polished edges; D6 head track, keyed locking device, all hardware and accessories required. Sill and jambs shall not be required.
 1. Application: Ice Cream Servery and locations indicated on the Drawings.
 2. Sizes: Custom, see Drawings.
 3. Finish: Satin clear anodized.
 4. Product: Daisy Model Pass-Thru Assembly with D6 overhead track by CR Laurence Co.

2.07 MISCELLANEOUS ACCESSORIES

- A. Miscellaneous Hardware: Provide all hardware required for intended glass applications.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings for glazing are correctly sized and within tolerance. Glass sizes indicated on the Drawings are approximate only.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. All frames shall be checked prior to glazing to make certain openings are square, plumb and secure in order that uniform face and edge clearances are maintained.
- C. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- D. Prime surfaces scheduled to receive sealant.
- E. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.
- F. Install sealants in accordance with manufacturer's instructions.

3.03 GLAZING METHODS

- A. All glazing shall be performed in accordance with standards of FGMA, AAMA and SIGMA, latest editions. Glass clearance dimensions shall be based on the type and thickness of the glass as determined by the FGMA Glazing Manual, or as hereinafter specified.
- B. No glass shall be installed where it may be damaged unless it is properly protected at all times. Any damaged or defective glass shall be removed and replaced with new perfect glass at no additional cost to the Owner.
- C. Install fire-rated glass in strict accordance with tested assemblies and the manufacturer's instructions and recommendations.

3.04 CLEANING

- A. Remove glazing materials from finish surfaces.
- B. Remove labels after Work is complete.
- C. Clean glass and adjacent surfaces.

END OF SECTION

SECTION 08 92 00
LOUVERED EQUIPMENT ENCLOSURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Louvered aluminum screens for concealing rooftop equipment.
- B. Fasteners and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Superstructure support and bracing of rooftop screens and grilles.
- B. Section 07 53 00 - Elastomeric Membrane Roofing: Treating penetrations for support of rooftop screens.
- C. Section 07 54 00 - Thermoplastic Membrane Roofing: Treating penetrations for support of rooftop screens.

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.
- C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2010.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.
- E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
- C. Shop Drawings: Include plans, sections, and details of connections and bracing.
 - 1. Include structural calculations indicating compliance with wind loading requirements.
 - 2. Show field measurements of roof openings on shop drawings.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available finishes, colors, and textures.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than ten years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Comply with manufacturer's instructions for handling of grille and screen products.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Submit manufacturer's standard ten-year finish warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Model EV811 by Ruskin Company.
- B. Industrial Louvers, Inc.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ROOFTOP EQUIPMENT SCREENS - GENERAL

- A. Wind Resistance: Design grilles and screens, including superstructure support system, to withstand positive and negative wind loading in accordance with applicable building code.

2.03 EXTRUDED HORIZONTAL LOUVERS

- A. Construction: Individual extruded aluminum louvers in inverted overlapping configuration, with blade supports attached to and supported by custom superstructure.
- B. Louver Blades: Alloy 6063-T6, per ASTM B221 (ASTM B221M), 0.80 inch thick, 4 inches deep, spaced at 5 inches on center, and configured to totally block sightlines from grade.
- C. Aluminum Finish: Factory finish louvers and accessories with a high-performance organic coating, as follows:
 - 1. Organic Coating: Clean and prime exposed aluminum surfaces and apply a fluoropolymer 2-coat finish conforming to AAMA 2605, with a minimum dry film thickness of 1.2 mil.
 - 2. Color: As selected from manufacturer's standard colors.
- D. Overall Screen Configuration: Dimensions, details, and layout as indicated on the drawings.

2.04 ACCESSORIES

- A. Miscellaneous Trim: Aluminum sheet, alloy 3005-H26 or equivalent per ASTM B209 (ASTM B209M), formed to shapes indicated and finished to match other components.
- B. Fasteners: Self-tapping stainless steel screws, as approved by manufacturer of rooftop equipment screens.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install rooftop equipment screens in accordance with manufacturer's printed instructions and approved shop drawings.
- B. Form tight joints and fit exposed connections accurately.
- C. Provide all necessary fastenings and anchors required for a complete installation. Install units plumb, level, and in proper alignment with adjacent work.

END OF SECTION

SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Note: Existing metal stud partitions indicated to receive new cabinet, countertop or other special loading, shall be investigated to determine stud thickness, size, spacing and top support conditions. An engineering analysis shall be conducted for accommodation of new loads, and to determine what, if any, structural improvements are required.
- C. Interior metal stud wall framing.
- D. Metal channel ceiling and soffit framing.
- E. Miscellaneous framing.
- F. Acoustic Construction, including installation of acoustic insulation and sealing of joints at framing and gypsum board.
- G. Installation of fire safing insulation at all tops of all stud walls and partitions and as specified herein.
- H. Shaftwall assemblies.
- I. Tile backer board.
- J. Gypsum wallboard.
- K. Marking and identification of fire-rated assemblies.
- L. Joint treatment, expansion and control joints, special shapes and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 71 00 - Cutting and Patching.
- B. Section 05 40 00 - Cold-Formed Metal Framing: Exterior wind-load-bearing metal stud framing and exterior sheathing.
- C. Section 06 10 54 - Wood Blocking and Curbing: Wood blocking for support of wall-mounted equipment.
- D. Section 07 21 00 - Thermal Insulation: Acoustic insulation.
- E. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire rated walls.
- F. Section 07 21 00 - Thermal Insulation.
- G. Section 07 90 05 - Joint Sealers: Acoustic sealant.
- H. Section 09 30 00 - Tiling: Tile backing board.

1.03 REFERENCE STANDARDS

- A. AISI S100- North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. Current edition.
- B. ANSI S200 - North American Standard for Cold-Formed Steel Framing - General Provisions.
- C. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
- D. ASTM A1003 - Standard Specification for Steel Sheet, Carbon, Metallic-Coated and Nonmetallic-Coated for Cold-Formed Framing Members; 2005.
- E. ASTM C475 - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2002 (Reapproved 2007).
- F. ASTM C 645 - Standard Specification for Nonstructural Steel Framing Members; 2008.

- G. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2011.
- H. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2013.
- I. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2011.
- J. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2014.
- K. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2014a.
- L. ASTM C1396- Standard Specification for Gypsum Board; 2011.
- M. ASTM C1658 - Standard Specification for Glass Mat Gypsum Panels; 2012.
- N. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2012.
- O. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.
- P. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- Q. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; 2013.
- R. GA-600 - Fire Resistance Design Manual; Gypsum Association; 2012.
- S. ICC (IBC) - International Building Code; 2009.
- T. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Submit details associated with fireproofing and acoustic seals.
 - 2. Submit fully engineered shop drawings of all new partitions with special loading conditions including but not limited to: wall mounted cabinets, shelving, grab bars, diaper changing stations, shower seats, and counters specified herein. Submit design criteria, calculations, size and thickness designations, type, location, spacing, connection to building structure, supplemental bracing or accessories, fasteners and details required for proper installation. Shop drawings shall bear the license seal of a professional structural engineer licensed to practice in the State of Maine.
 - 3. Submit color coded floor plans with partition colors keyed to stud manufacturer's color coding system indicating extents of each stud / partition assembly type.
- C. Product Data:
 - 1. Submit manufacturer's metal stud load tables for typical stud partition loading and deflection criteria, identifying stud height, size and thickness selections.
 - 2. Provide data on metal framing runners, head tracks, metal framing, gypsum board, accessories, and joint finishing system.
 - 3. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- D. Test Reports: For stud framing products that do not comply with ASTM C645 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- E. Samples:
 - 1. Upon request, submit samples of all materials and accessories.

1.05 QUALITY ASSURANCE

- A. Panel Products and Finishing Manufacturer: Unless otherwise indicated, gypsum board and other panel products, accessories and finishing materials shall be from a single manufacturer.
- B. Metal Framing Manufacturer: Unless otherwise indicated, steel framing for gypsum board assemblies shall be from a single manufacturer.
- C. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 5 years of documented experience.
- D. Framing components and assemblies required to be engineered and detailed on shop drawings shall include proper accommodations for all live and dead loads, differential building movement, etc. Provide industry standard safety factors as suited to specific job conditions. To the extent that component types and sizes are indicated in the Contract Documents, they shall be considered minimum requirements to be verified and increased (but not decreased) as determined to be necessary by the metal stud contractor's engineer. Framing member depths indicated on the Drawings shall not be altered without the Architect's prior written authorization.

1.06 PRE-INSTALLATION MEETING

- A. At least 3 weeks prior to start of installation of metal framing systems, meet at the project site with installers of other work including door and window frames, mechanical and electrical work. Review areas of potential interference and conflicts, coordinate layout, and support provisions for interfacing work.

1.07 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered to the job site in their original unopened containers or bundles, stored flat under conditions providing adequate protection from damage and exposure to elements and adequately protected from foul weather conditions.
- B. Steel framing and related accessories shall be stored and handled in accordance with AISI Code of Standard Practice.
- C. All fire-rated materials shall bear testing agency labels and required classification numbers.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.
- B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC as indicated on the Drawings, calculated in accordance with ASTM E413 by a qualified independent testing agency, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 - 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- D. Fire Rated Assemblies: Provide completed assemblies as indicated on the Drawings. Materials and construction shall be identical to assemblies whose fire resistance rating has been determined per ASTM E119 by a testing and inspection service acceptable to the Authority Having Jurisdiction. Materials provided shall meet or exceed flame, fuel and smoke requirements of ASTM E84 surface burning characteristics for finish materials.
 - 1. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
 - 2. UL Assembly Numbers: Comply with requirements listed for each particular assembly in the current UL Fire Resistance Directory.

- E. Design Requirements:
1. Steel partition stud maximum spacing: 16 inches on center.
 2. Each partition (defined as full extent within a room) shall be composed of one stud type and one thickness.
 3. Steel partition stud lateral deflections:
 - a. Typical gypsum board faced partitions: L/240.
 - b. Ceramic tile faced partitions: L/720.
 - c. Stone and masonry veneer faced partitions: L/720.
 4. Steel partition stud uniform lateral loads:
 - a. Typical gypsum board faced partitions: 5 PSF.
 - b. Ceramic tile faced partitions: 8 PSF.
 - c. Stone and masonry veneer faced partitions: 15 pounds per sq ft.
 5. Steel partition stud special loads in addition to uniform lateral loads:
 - a. Wall mounted cabinets: Minimum 60 PLF applied vertically 6" from the face of the wall (for a 12" deep cabinet).
 - b. Wall mounted shelving: Minimum 20 PLF per shelf applied vertically 6" from the face of the wall for four (4) shelves spaced 12" apart with top shelf at 6 feet AFF (for a 12" deep shelf).
 - c. Wall mounted counters: Minimum 100 PLF applied vertically 12" from the face of the wall (for a 24" deep counter) and applied vertically 15" from the face of the wall (for a 30" deep counter).
 - d. Wall mounted handrails: Minimum concentrated force of 200 pounds applied at any point in any direction and, but not simultaneously, a uniform load of 50 PLF applied in any direction 4" from the face of the wall.
 - e. Wall mounted stationary grab bars: Minimum concentrated force of 250 pounds applied at any point in any direction 4" from the face of the wall.
 - f. Retail display walls: Minimum 20 PSF applied vertically 6" from the face of the wall (for 12" deep display support brackets).
 - g. Wall mounted diaper changing stations: Minimum concentrated force of 200 pounds applied at any point in any direction 11" from the face of the wall (for a 22" deep changing station).
 - h. Wall supported gypsum board framed ceiling: Ceiling dead load of 7 PSF.
 - i. Wall mounted televisions: Minimum concentrated force of 60 pounds applied at any point in any direction 8" from the face of the wall.
 6. Steel soffit and ceiling framing studs lateral deflection: L/240.

2.02 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
1. Dietrich Metal Framing.
 2. Marino\Ware .
 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Framing System Components: ASTM C 645, roll-formed steel.
1. Protective Coating: ASTM A653 minimum G60 (Z180) hot-dip galvanized corrosion resistant coating.
 2. Sizes: Sizes and properties necessary to comply with ASTM C 754 and for the spacing, deflection and load conditions indicated, but in no case less than 18 mils (0.0179 inches) minimum thickness.
 3. Studs: C shaped with flat or formed webs, 1-1/4" legs (flanges) with knurled faces; web depths as indicated on the Drawings.
 4. Runners: U shaped, sized to match studs.
 5. Contoured Runners: U shaped, sized to match studs. Contour Track by Clark Dietrich or equal.
 6. Slip-Type Head Track Options:

- a. Single Long-Leg Runner System: ASTM C645 top runner with 2 inch deep flanges in thickness as required by engineering but not less than stud thickness, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
- b. Double-Runner System: ASTM C645 top runners, inside runner with 2 inch deep flanges in thickness as required by engineering and fastened to studs, and outer runner sized to friction fit inside runner and in thickness as required by engineering but not less than stud thickness.
- c. Deflection Track: Steel sheet top runner to accommodate deflection of structure above; in thickness as required by engineering but not less than stud thickness and in width to accommodate depth of studs.
7. Ceiling Carrying Channels: C shaped, minimum 54 mils (0.0538 inches); minimum 1/2 inch wide flanges; depth 3/4", 1-1/2", 2", 2-1/2" and as indicated on the Drawings.
8. Furring Channels:
 - a. Hat-shaped sections, depth of 7/8 inch with 1/2 inch wide flanges; 22 ga (0.269 inch).
9. Resilient Furring Channels: 1/2 inch depth, designed to reduce sound transmission, for attachment to substrate through one leg only; minimum 20 mils (0.0195 inch)
10. Channel Bridging and Bracing: U shaped; 54 mils thickness; minimum 0.5 inch wide flanges; depth as indicated or required.
- C. Shaft Wall Studs and Accessories: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 and specified performance requirements.
 1. Shaft wall assemblies shall be engineered by the manufacturer/fabricator and shall be tested by an approved testing agency for fire-rating requirements as indicated on the Drawings. Deflection and load requirements as per paragraph 2.01 above.
 2. All materials shall come from a single source.
- D. Ceiling and Soffit Suspension Systems: Comply with ASTM C754.
 1. Interior Ceilings and Soffits:
 - a. Carrying Channels, Furring Channels, Resilient Channels: See above.
 - b. Flat steel hangers: Zinc coated sheet steel; type and size as specified in ASTM C754 for spacing required; minimum size 1 inch x 3/16 inch by length required.
 - c. Wire Hangers: ASTM A641, Class 1 zinc coating, soft temper, sized for the specific application, but in no case less than 0.162 inch diameter.
 - d. Tie Wire: ASTM A641, Class 1 zinc coated, soft temper, sized for the specific application, but in no case less than 0.0625 inch or double strand of 0.0475 inch diameter wire.
 - e. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E488.
 2. Acoustic Isolators: (For hangers in Bistro, Pub and Board Room Ceilings). Space in accordance with manufacturer's load carrying recommendations based on the weight of the ceiling assembly including; framing, gypsum board, acoustic panels and lighting.
 - a. Products:
 - 1) Model AF-200 by Kinetics Noise Control.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- E. Clips (For securing head tracks to structural components intended to receive sprayed-on fireproofing): Galvanized steel, depth as required for thicknesses of fireproofing, size and thickness as determined by system engineering.
- F. Partition Head To Structure Connections (Deflection Head Tracks): Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as determined by the fabricator/installer's engineering. In no case shall tracks be less than 33 mils

2.03 BOARD MATERIALS

- A. Manufacturers: Except as indicated otherwise, the names and catalogue numbers of United States Gypsum Co. have been used to establish type and quality of materials.
 - 1. BPB America Inc - CertainTeed.
 - 2. Georgia-Pacific Gypsum.
 - 3. National Gypsum Company.
 - 4. USG Corporation.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Gypsum Wallboard: Type X paper-faced gypsum panels as defined in ASTM C 1396; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. At toilet rooms provide moisture-resistant type wallboard unless otherwise noted.
 - 3. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 4. Thickness: 5/8 inch.
 - 5. Paper-Faced Products:
 - a. CertainTeed Corp; ProRoc Brand Gypsum Board.
 - b. Georgia-Pacific Gypsum; ToughRock Fireguard, and ToughRock FireGuard C.
 - c. National Gypsum Co; Gold Bond Brand Gypsum Wallboard.
 - d. USG Corp; Sheetrock Brand Gypsum Panels.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 6. Mold-Resistant Paper-Faced Products:
 - a. CertainTeed Corp; ProRoc Brand Moisture & Mold Resistant Gypsum Board.
 - b. Georgia-Pacific Gypsum; ToughRock Mold-Guard Type X Gypsum Wallboard.
 - c. National Gypsum Co; Gold Bond Brand XP FireShield Gypsum Board with Sporgard.
 - d. USG Corp; Sheetrock Brand Mold Tough Gypsum Panels.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 7. Flexible Gypsum Board:
 - a. Thickness: 1/4 inch.
 - b. Total Thickness: 1/2 inch, minimum two layers, stagger joints.
 - c. Applications: Curved wall and column wrap areas specified to receive gypsum sheathing with radius.
 - d. Product: 1/4" Flex Gypsum Board by CertainTeed Corp.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Backer Board:
 - 1. See Section 09 30 00 Tiling.
- D. Exterior Gypsum Sheathing Board: As specified in Section 05 40 00.
- E. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
 - 1. Glass Mat Faced Type: ASTM C1658, glass mat shaftliner gypsum panel or glass mat coreboard gypsum panel.
 - 2. Mold Resistance, ASTM D3273: Score of 10.
 - 3. Products:
 - a. Georgia-Pacific Gypsum; DensGlass Shaftliner (mold-resistant).
 - b. National Gypsum Co; Gold Bond Brand e2XP Extended Exposure Shaftliner.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 ACCESSORIES

- A. Acoustic and Firestop Insulation: As specified in Section 07 21 00.
- B. Acoustic and Smoke Sealant: As specified in Section 07 90 05.
- C. Fire-stop Sealant: As specified in Section 07 84 00.

- D. Finishing Accessories for Wallboard: ASTM C 1047, galvanized steel or rolled zinc, not less than 26 gage, unless otherwise indicated.
 - 1. General Types: As detailed or required for finished appearance.
 - 2. "J" Beads: Channel shaped with a concealed wing not less than 1-1/8" wide and an exposed wing, equal to Type 400. "J" beads may be used only where specifically identified on the Drawings or otherwise approved by the Architect. All other edge trim shall be Casing Beads.
 - 3. Casing and Trim Beads: Channel and angle types as required, screwed into place and suitable for finishing with joint compound, equal to Type 200.
 - a. Vinyl Rip Bead L Trim is acceptable.
 - 4. Corner Beads: Angle-shaped with 1-1/4" width wings, and perforated for screwing and joint treatment, equal to Type 103. Use Mult-Flex, steel reinforced, tape bead for corners less than or greater than ninety degrees.
 - 5. Edge Beads: (For use at perimeter of ceilings) Channel or angle-shaped with wings not less than 3/4" wide. Exposed wing edge shall be folded flat, with bead for taping and floating, equal to Type 200.
 - 6. Control Joints: Zinc extrusions equal to Type 093, or deep rigid PV extrusions equal to Type 093V by Trimtex for larger joints.
 - 7. Miscellaneous Shapes: In addition to conventional cornerbead and control joints, provide other configurations indicated or as otherwise required for a complete and proper job. At exterior locations provide exterior grade rigid PVC trims.
 - 8. Manufacturers - Finishing Accessories:
 - a. Same manufacturer as framing materials.
- E. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
 - 1. Tape: 2 inch wide, creased paper tape for joints and corners for all interior locations.
 - 2. Ready-mixed vinyl-based joint compound.
- F. High Build Drywall Surfer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish for semi-gloss painted surfaces.
 - 1. Product: Tuff-Hide manufactured by USG.
- G. Screws for gypsum board attachment to Steel Members Less Than 0.03 inch In thickness; to Wood Members; ASTM C1002; self-piercing tapping type, Type W for wood studs and Type S for steel studs, 1-1/4" length.
 - 1. Coatings: Black oxide coated for general use; Zinc plated chromate for areas of potential dampness.
- H. Screws for gypsum board attachment to Steel Members From 0.033 to 0.112 Inch in thickness: ASTM C 954; steel drill screws for application of gypsum board to loadbearing steel studs.
 - 1. Size, penetration and spacing shall be in strict accordance with the stud manufacturer's recommendations and the stud fabricator's engineering requirements. Penetration through joined steel materials shall not be less than 3 exposed threads or 3/8".
 - 2. Coatings:
 - a. General interior areas: Corrosion resistant, zinc plated with chromate complying with ASTM B633 and B117.
 - b. Potentially damp interior areas: High performance polymer coating, complying with ASTM B117; salt spray test result of no rust or other base metal corrosion after a minimum of 800 hours.
 - 1) Products: Stahlgard by ELCO, Kwik-Cote by Hilti, or approved equal.
- I. Anchorage to Substrate: Anchorage of tracks to the structure (size, penetration, type and spacing) shall be in strict accordance with the stud fabricator/installer's engineering requirements for the specific application and shall rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this Section to commence.

3.02 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
 - 2. Install firestopping sealant in a continuous application at the perimeter of the shaftwall in coordination with framing installation and Section 07 84 00.
 - 3. Install J-runners or E-studs on columns and beams before fireproofing installation. Remove all fireproofing over-spray from shaft wall framing before installing gypsum liner panels.
 - 4. Install studs at spacing required to meet performance requirements. C-H studs shall be sized 3/8 inch to 1/2 inch less than the floor-to-ceiling height, and installed between liner panels. Install full length E-studs or J-runners vertically at T intersections, corners, door jambs, and columns. Install full length E-studs over gypsum liner panels both sides of closure panels. For openings, frame with vertical E-stud or J-runner at edges and horizontal J-runner at head and sill. Frame all openings as required to maintain structural support of wall. Isolate framing from transfer of lateral and vertical structural loading to the system. Provide movement relief type joints per manufacturer's instructions to attain proper lateral support.
 - 5. For openings, frame with vertical E-stud or J-runner at edges and horizontal J-runner at head and sill. Frame all openings as required to maintain structural support of wall.
 - 6. Install supplemental framing and bracing to support fixtures, equipment, services, heavy trim, etc which cannot be adequately supported directly on shaftwall framing.
- B. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.
 - 1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
- C. Horizontal Shaftwall Systems: Studs for horizontal systems shall be sized to accommodate partition dead loads as well as other applicable loads.
- D. Seal perimeter of shaft wall and penetrations with firestop sealant.
- E. Shaft Wall With Finish on One Side:
 - 1. Install gypsum board in a double layer on one side, either horizontally or vertically.
 - 2. Install the first layer of gypsum board horizontally with approved fasteners spaced 24 inches o.c. and 3 inches from all edges.
 - 3. Offset the horizontal joints minimum 12 inches from any splice joints in the liner board panels.
 - 4. Install the face layer of gypsum board parallel to the framing with approved fasteners spaced minimum 12 inches o.c. and 6 inches from all edges.
 - 5. Finish joints with tape and compound.

3.03 FRAMING INSTALLATION

- A. Metal Framing: Comply with ASTM C 754, fabricator's engineering drawings and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated and in accordance with fabricator's engineering drawings. Suspend carrying channels from structure above at not more than 4 feet on center and within 6 inches of walls. Attach furring channels to the carrying channels at no more than 16 inches on center and within 2 inches of walls.
 - 1. Level ceiling system to a tolerance of 1/8" in 12'.
 - 2. Install hangers plumb and free of contact with other objects that are not part of the supporting system for the ceiling. Install supplemental suspension members where width of ducts or other construction interferes with hanger locations.

3. Provide control and expansion joints as indicated on the Drawings, or otherwise required.
 4. Laterally brace entire suspension system. Reinforce openings in suspension system which interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing a minimum of 24 inches past each opening.
 5. Install bracing as required at exterior locations to resist wind uplift.
 6. NOTE: At the Contractor's option, drywall direct suspension systems may be used, in lieu of the carrying/furring channel system specified, subject to review and acceptance by the Architect. Direct suspension systems shall be complete with main beams, cross channels, wall angles, clips, and hangers, and shall be as recommended by the gypsum board manufacturer for the proposed installations. Systems shall be suitable for fire-rated installations as required.
 7. Fasteners for hanger wires shall be of types and sizes that will resist corrosion, and provide lasting anchorage without pullout or failure. Verify compatibility with structure to receive fasteners prior to proceeding. Do not attach hangers to steel roof deck or steel deck tabs.
- C. Runner Tracks: Install continuous tracks sized to match stud, aligned accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer and engineered design for type of construction involved.
- D. Coordination with sprayed on fireproofing: Before sprayed on fireproofing is applied, attach offset clips to steel surfaces per engineered shop drawings.
1. At existing fireproofing, remove only as much fireproofing as needed to complete installation of offset clips for support of new steel studs. Spray fireproofing shall be touched up to maintain required coverage and thickness for fire resistive rating as part of the scope of Section 07 81 00. Do not conceal conditions by installation of gypsum board prior to required spray fireproofing touch-up.
- E. Studs: Space studs at 16 inches on center unless closer spacing is required by the fabricator's engineering. Spacing shall not exceed 16 inches without the Architect's prior written authorization.
1. Extend partition framing to structure in all locations.
 2. Partitions Terminating at Structure: Provide deflection head track at all locations where metal framing is attached to or otherwise affected by the deflection of other structural building components. Secure the top of studs in such a way as to allow movement of the deflection head track with respect to the studs. Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging, or as otherwise required by the fabricator's engineering drawings.
 3. Provide minimum clear space as indicated on the partition types on the Drawings for deflection.
- F. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs of all window and door openings and shall be located not more than 2 inches from frames jambs. Two jamb studs shall be used for any opening larger than 2 feet square. Over door frames install a cut-to-length section of runner with flanges slit and web bent to allow flanges to overlap adjacent vertical studs and securely screw-attached to adjacent studs. A cut-to-length stud extending from door frame header to ceiling runner shall be positioned over the door frame.
1. Provide additional framing as required by engineered design to reinforce headers for adequate stability.
 2. Unless otherwise indicated on the Drawings, partitions above and below door and window openings shall be the same construction as adjacent partitions.
- G. Standard Wall Furring: Install at concrete and masonry walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.

- H. Blocking: As part of the scope of Section 06 10 54 - Wood Blocking and Curbing, install wood blocking for support of:
 - 1. Framed openings.
 - 2. Wall mounted cabinets.
 - 3. Toilet partitions.
 - 4. Toilet accessories.
 - 5. Wall mounted door hardware.
 - 6. Grab bars and hand rails
 - 7. Wall mounted countertops
- I. Supplemental Framing: Install supplementary framing, blocking and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the walls or partitions. Where type of supplementary support is not otherwise indicated by the engineered design, comply with stud manufacturer's recommendations and industry standards in each case, considering weight or loading resulting from item supported, for firm and rigid construction.
- J. Penetration and Opening Insulation: Install firesafing insulation as required to meet firestop product manufacturer's tested assemblies for all openings and penetrations in fire-rated construction, smoke partitions and at acoustic sealing. Openings shall include steel deck flutes, structural penetrations, mechanical, electrical, piping, etc. Provide any necessary extra studs, furring channels or stick-clips to ensure that insulation will remain in proper alignment and fit around items penetrating partitions.
- K. Expansion and Control Joints: Provide studs at each side of all horizontal and vertical joints. Space studs to align with width of joints. Stuff voids between studs full with firesafing insulation at all locations.
 - 1. Coordinate with the installation of expansion joint covers. See Section 07 95 13 - Expansion Joint Cover Assemblies.
- L. Fire-resistive Wall and Ceiling Assemblies: Where fire-rated assemblies are required, provide materials and construction identical to the Underwriters Laboratories (U.L.) tested assemblies as referenced on the Drawings.

3.04 BOARD INSTALLATION

- A. General: Inspect materials to which gypsum board is to be applied. Remedy all defects prior to installation of gypsum materials. Maintain a uniform room temperature between 55 and 65 degrees F during application and until completely dry or occupied. Provide adequate ventilation to carry off excess moisture.
- B. Field verify the layout of all walls and partitions prior to proceeding with the Work, in order to avoid dimensional errors and confirm proper placement. Verify that all required insulations are properly in place prior to covering up.
- C. Where the Drawings indicate multiple partition or wall types back-to-back, each scheduled type shall be complete. Inner layers of insulation or gypsum board shall not be omitted.
- D. Comply with ASTM C 840 and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
 - 1. Gypsum wallboard shall be cut by scoring and breaking, or by sawing, working from the face side. Scribe neatly to projecting surfaces and fit wallboard neatly around pipes, ducts and other penetrations.
 - 2. Apply wallboard first to soffits (ceilings) then to walls. Allow 1/4" maximum space between bottom of wall sheets and floor, unless otherwise noted. Apply wallboard at interior soffits with long dimensions of board perpendicular to axis of supports.
 - 3. At ductwork and piping provide a 1/2 inch gap between the drywall and the penetrating element to minimize any vibrational noise transmission to the partition. Void shall be acoustically sealed.

- E. Single-Layer Non-Rated: Install gypsum board perpendicular to framing, with ends and edges occurring over firm bearing.
- F. Double-Layer Non-Rated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- G. Fastening Gypsum Wall and Soffit Board: Wallboard shall be held in firm contact with the supports while the fasteners are being driven. Fasteners shall proceed from central portion of board towards ends and edges. Fasteners shall be driven home with the heads slightly below the surface of the board in a dimple formed by the driving tool. Care shall be taken to avoid breaking the paper face. Improperly driven fasteners shall be removed.
 - 1. In general, drywall screws shall be spaced not to exceed 16 inches o.c. At fire-resistive construction, space screws 12 inches o.c. in field and 8 inches o.c. at board perimeters, unless otherwise required by the applicable U. L. fire-rated assembly.
- H. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- I. Curved Surfaces:
 - 1. Comply with manufacturer's requirements for fastener type and spacing.
 - 2. Double Layer Construction: Apply base layer perpendicular to framing, offsetting base layer from face layer joints one framing member apart. Fasten to framing with screws spaced no greater than 12" apart.
 - 3. Application of multiple layers of 1/4" or 3/8" thickness gypsum panels to form greater thicknesses is acceptable for non-fire rated assemblies.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces, as recommended by the gypsum board manufacturer, and as indicated. Locations not indicated on the Drawings shall be located by the Contractor subject to the Architect's prior approval. Provide control joints or expansion joints where partitions, walls, ceilings, or soffits cross construction or building joints in stud framing or other supporting materials.
 - 1. At building expansion joints,
 - 2. At intersections of dissimilar substrates or finish materials,
 - 3. At floor lines,
 - 4. At ceiling and soffit intersections with a structural element or the vertical penetration,
 - 5. At ceiling wings of "L", "U" and "T" shaped ceiling areas,
 - 6. At openings more than 6 feet long,
 - 7. Adjacent to corners and intersections of walls within a distance equal to half the general control joint spacing noted above.
 - 8. At walls not more than 30 feet apart and ceilings over 30 feet long without relief,
 - 9. At walls with tile finish, no more than 16 feet apart in either direction,
 - 10. At locations where concentrated stress or movement is anticipated,
 - 11. At all locations identified on the Drawings,
 - 12. At locations as recommended by the board manufacturer.
- B. Control joint width shall be as required to accommodate anticipated movement.
- C. Control joint in fire-rated construction shall meet requirements of the fire-resistive tested assemblies.
- D. Wall boards shall be discontinuous at the joint, sealant shall fill the gap and control joint trim shall be fastened at both flanges along the entire length of the joint.
- E. Corner Beads: Install with screws at external corners, using longest practical lengths.
- F. Casing Beads: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.06 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.
- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 2. Level 5: Walls and ceilings to receive semi-gloss paint finish and other areas specifically indicated.
 - 3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 4. Level 1: Wall areas above finished ceilings and in attics, whether or not accessible in the completed construction.
 - 5. Level 0: Temporary partitions.
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 - 2. Taping, filling and sanding is not required at base layer of double layer applications, except as required in fire-rated applications.
- E. All wallboard in fire-rated and smoke sealed construction shall be sealed when penetrated by pipes, conduits, wire, structure, etc.
 - 1. Smoke sealed assemblies shall be sealed tight to abutting construction with sealant products.
 - 2. Fire-rated assemblies shall be sealed tight to abutting construction with firestopping products in order to provide continuous, uninterrupted fire protection.
- F. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.07 MARKING OF FIRE AND SMOKE RESISTIVE CONSTRUCTION

- A. Prepare stenciled signs for painted marking of all fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions as identified on the Code Analysis Drawings, above accessible ceilings, in attics and in accessible concealed floor spaces, at intervals not exceeding ten (10) feet measured horizontally.
 - 1. Lettering shall be 3 inches high, of contrasting color to the application surface.
 - 2. Sign text shall be as follows, as applicable:
 - a. FIRE WALL - PROTECT ALL OPENINGS
 - b. FIRE BARRIER - PROTECT ALL OPENINGS
 - c. FIRE PARTITION - PROTECT ALL OPENINGS
 - d. FIRE AND SMOKE BARRIER - PROTECT ALL OPENINGS
 - e. SMOKE PARTITION - PROTECT ALL OPENINGS

3.08 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09 30 00
TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Floor tile and base.
- B. Wall tile.
- C. Tile backer board - coated glass mat.
- D. Accessories.
- E. Ceramic trim.
- F. Non-ceramic trim.
- G. Note: See the Drawings for special conditions and details, such as specific patterns, alternate colors, inserts, etc.
- H. Note: All floor and wall tile installations shall be laid in standard patterns by the manufacturer. For bidding purposes, it shall be assumed that the ratio of field tile area to accent tile area shall be 90/10. Multiple accent tile colors shall be selected. Tile shall not be ordered until final patterns have been established and approved by the Architect.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - GYPSUM BOARD ASSEMBLIES: Tile backer board.
- B. Division 22 - Plumbing: Shower receptor.

1.03 REFERENCE STANDARDS

- A. ANSI A108 Series / A118 Series / A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2012.1.
 - 1. ANSI A137.1 - American National Standard Specifications for Ceramic Tile - Version; 2013.1.
- B. ASTM C1178 - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2011.
- C. TCNA - Handbook for Ceramic, Glass, and Stone Tile Installation; 2012.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Convene a pre-installation meeting at least two weeks before starting work of this Section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, backer board and accessories. Include instructions for using grouts and adhesives.
- C. Samples: Submit confirmation samples of each tile and color selected.
- D. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than 10 square feet of each type.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of ANSI A108/A118/A136.1 and TCNA (HB) on site.

- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this Section, with minimum ten years of documented experience.
- C. Installer Qualifications: Company specializing in performing commercial tile installation, with minimum of 5 years of documented experience.

1.07 MOCK-UPS

- A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
- B. Construct mock-up for each type of flooring transition to include leveling and shimming products, flooring on both sides of the transition and transition strips. The Owner shall test each mock-up for ease of movement for wheeled equipment. Flooring transitions shall provide smooth, bump-free transitions to facilitate movement of wheeled equipment and minimize tripping hazards.
 - 1. Approved mock-ups may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.
- B. Deliver all products to job site in manufacturer's unopened, original containers with grade seals and marking intact. Keep tile cartons dry.

1.09 FIELD CONDITIONS

- A. Do not install solvent-based products in an unventilated environment.
- B. Maintain ambient and substrate temperature of 50 degrees F during installation of tilework and for 7 days after completion.
- C. Provide adequate lighting for good grouting and cleanup.
- D. Place in clean marked cartons exclusively for the Owner's use. Send written notice to the Architect identifying the quantity and location of extra tile furnished.

1.10 OWNER TRAINING

- A. A ceramic tile cleaning and maintenance training session for the Owner shall be held at the completed facility conducted by a qualified representative of the tile manufacturer. Printed tile maintenance instructions shall be provided to the Owner in advance of the training session.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers:
 - 1. Refer to the Interior Design Finish Schedule on the Drawings.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Floor Tile Types T-1, -1a, -2, -9 & -9a: ANSI A137.1 Porcelain.
 - 1. Product(s): See Finish Legend.
 - 2. Moisture Absorption, ASTM C373: 0 to 0.5 percent.
 - 3. Sizes, Shapes and Colors: See Finish Legend.
 - 4. Edges: Square.
 - 5. Provide tile preset on dot-mounted sheet.
 - 6. Tile for epoxy grout shall be provided with grout release coating.
 - 7. Coefficient of Friction, ASTM C1028: Dry > 0.8; Wet > 0.6.
 - 8. Bond Strength, ASTM C482: > 200 psi.
 - 9. Color(s): As shown on drawings.
 - 10. Base Type: See Finish Legend.
- C. Glazed Wall Type T-7 & -8: ANSI A137.1 porcelain.
 - 1. Product(s): See Finish Legend.
 - 2. Moisture Absorption: 3.0 to 7.0 percent.
 - 3. Size and Shape: See Finish Legend.

4. Edges: Square.
 5. Patterns / Colors: See Finish Legend.
 6. Trim Units: Matching bead, bullnose, cove, and base shapes in sizes coordinated with field tile. Provide bullnose caps on all exposed edges.
- D. Glass/Stone Tile - Mosaic Type T-3, -4 & -5:
1. Mesh-Mounted Tiles:
 - a. Size and Shape: See Finish Legend.
 2. Face: Smooth.
 3. Edges: Square.
 4. Color(s): per the Finish Legend.
 5. Products: See Finish Legend.
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Concrete Wall Tile Mosaic Type T-6:
1. Mesh-Mounted Tiles:
 - a. Size and Shape: See Finish Legend.
 2. Thickness: Varied, 3/8 to 1 inch.
 3. Colors: Per Finish Legend.
 4. Products: See Finish Legend.
 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 TRIM AND ACCESSORIES

- A. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
1. Applications:
 - a. Open Edges: Bullnose.
 - b. Inside Corners: Jointed.
 - c. Floor to Wall Joints: Cove base.
 2. Manufacturers: Same as for tile.
- B. Non-Ceramic Trim: Satin natural anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
1. NOTE: All flooring transitions shall be executed to provide a smooth and level floor surface.
 2. Applications:
 - a. Open edges of wall tile.
 - b. Open edges of floor tile.
 - c. Thresholds at door openings.
 - d. Expansion and control joints, floor and wall.
 3. Manufacturers:
 - a. Schluter-Systems.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 SETTING MATERIALS

- A. Provide setting materials made by the same manufacturer as grout.
- B. Self-Leveling Underlayment: For all ceramic tile floor areas except toilet rooms.
1. Product: Drytek 7200 by Laticrete.
- C. Primer: As required for self-leveling underlayment.
- D. Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.
1. Products:
 - a. ; LATICRETE LATAPOXY 300 Adhesive by Laticrete.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 GROUTS

- A. Manufacturers:
 - 1. Bostik Inc
 - 2. Laticrete.
 - 3. Mapei
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
 - 1. Applications: Wall Tile.
 - 2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
 - 3. Color(s): See Finish Legend.
 - 4. Products:
 - a. LATICRETE PermaColor by Laticrete.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
 - 1. Applications: Floor tile.
 - 2. Color(s): As selected by Architect from manufacturer's full line.
 - 3. Products:
 - a. LATICRETE SpectraLOCK PRO Premium Grout by Laticrete.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Thickness: 20 mils, maximum.
 - 2. Crack Resistance: No failure at 1/16 inch gap, minimum.
 - 3. Products:
 - a. Blue 92 Anti-Fracture Membrane by Laticrete.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Flooring Transitions:
 - 1. At ceramic/porcelain tile flooring to resilient or carpet flooring transition:
 - a. Product: Schiene as manufactured by Schluter.
- C. Uncoupling Membrane: 1/8 inch thick polyurethane matting with three-dimensional grid structure with dovetail shaped cavities and fleece webbing laminated to the underside to provide a mechanical bond to the substrate adhesive.
 - 1. Product: Ditra by Schluter Systems.
- D. Waterproofing Membrane at Floors: ANSI A118.10.
 - 1. Type: Bonded Sheet Membrane.
 - 2. Material: Synthetic rubber.
 - 3. Products:
 - a. Hydro Ban by Laticrete.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Backer Board (for tile):
 - 1. Coated Glass Mat Backer Board: ASTM C1178, coated inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder.
 - a. Standard Type: Thickness 1/2 inch.
 - b. Fire-Resistant Type: Type X core, thickness 5/8 inch.
 - c. Products:
 - 1) Denshield Tile Backer by Georgia-Pacific.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- F. Mesh Tape: 2-inch wide self-adhesive fiberglass mesh tape.

- G. Tile and Grout Cleaners / Sealers: As recommended by the tile and grout manufacturers.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before installing any ceramic tile inspect surfaces to receive tile and accessories. Notify the Architect in writing of any defects or conditions that will prevent a satisfactory tile installation. Do not proceed with installation until satisfactory corrections have been made. Start of work implies acceptance of surfaces to receive tile.
- B. In general, tile floors shall slope to floor drains. Verify proper floor pitches prior to start of the Work. Elevation adjustment coat shall be provided as required. All conditions requiring adjustments shall be reviewed with the Architect prior to start of Work.
- C. Large Format Tile with 1/8" Grout Joints: Sub-floor surfaces shall receive self-leveling underlayment.
1. Surface shall be clean and free from dirt, dust, sealer or other surface contaminants. Surface shall receive self-leveling underlayment roughener prior to installation of the underlayment.
 2. Prime all areas and allow to dry.
 3. Install self-leveling underlayment. Materials may be installed from 1/16" to 1.5" thickness at one time.
 4. Install water-resistive membrane over all areas to be tiled. Membrane shall fully dry before proceeding with tile installation.
- D. Small Format Tile: Verify that sub-floor surfaces are smooth and flat, within tolerances of not more than 1/8" in 10 feet and are ready to receive tile. Leveling coat shall be provided as required.
- E. Adjust sub-floor surfaces at transitions to other flooring materials to provide a smooth transition of floor surfaces to facilitate movement of wheeled equipment, wheelchairs and minimizes tripping hazards.
1. Mock-ups of each type of flooring transition shall be tested by the Owner and approved by the Architect prior to project-wide implementation.
- F. Verify that wall and ceiling surfaces are smooth, flat, with square corners, within tolerances of not more than 1/8" in 8 feet, are dust-free, and are ready to receive tile. Leveling coat shall be provided as required.
- G. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.
- H. The Owner shall provide testing to verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.
- I. Do not start work until grounds, anchors, hangers, bucks, electrical, and mechanical work in or behind tile have been installed. Do not proceed until adjoining work is satisfactorily protected.
- J. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.

- E. Install backer board in strict accordance with manufacturer's instructions, using galvanized or corrosion resistant coated fasteners. Bed fiberglass self-adhesive tape at all joints and corners with material used to set tiles.
- F. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with best current practice of the industry and applicable requirements of ANSI A108.1 through A108.13, manufacturer's instructions, and TCA Handbook recommendations.
- B. Field verify all layouts and patterns with the Architect prior to proceeding. Lay tile to pattern indicated. Do not interrupt tile pattern through openings. Align joints when adjoining tiles on floor, base, walls and trim are the same size.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Make all cuts on the outer edges of the field. Smooth all cut edges with a carborundum stone, and install no tile with jagged or flaked edges. Form corners and bases neatly. Align floor joints.
- D. Extend tile into recesses and under equipment and fixtures to form a complete covering without interruption.
- E. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Expansion Joints: Provide expansion joints directly over all building movement joints, whenever tile abuts restraining surfaces and not more than 20' on center each way in the tile field. Proposed joint details and locations shall be submitted for review to the Architect. Keep expansion joints free of adhesive or grout. Apply sealant to joints.
 - 1. Expansion joints over movement joints shall be equal in width to the joints below. Other expansion joints shall be width of grout joint or 1/8", whichever is greater.
 - 2. Install in accordance with TCA Handbook Method EJ171.
 - 3. Install uncoupling membrane at expansion and control joints.
- J. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- K. Grout tile joints.
- L. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.
- M. Epoxy grout shall be removed from tile surfaces immediately during grouting operations.
- N. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes. All inside corner of ceramic wall tile in wet areas shall be kept free of grout and shall be sealed with a continuous bead of silicone, color to match grout.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113,, with epoxy grout, unless otherwise indicated.
 - 1. Use uncoupling membrane under all tile unless other underlayment is indicated.
 - 2. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122.

3.05 INSTALLATION - WALL TILE

- A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

3.06 CLEANING

- A. Upon completion of setting and grouting, sponge and wash tile thoroughly, diagonally across joints. Use tile and grout cleaners as recommended by the manufacturer. Finally polish with clean, dry cloths.
- B. Epoxy grout shall be removed from tile surfaces immediately during grouting operations.
- C. Do not use acid or acid cleaners to clean glazed tile. Acid cleaning of unglazed tile shall not be done before 10 days after setting, and then only when approved by the tile manufacturer.
- D. Clean and seal all floor tile surfaces with product recommended by the manufacturer for each type of tile and anticipated traffic just prior to Substantial Completion.

3.07 PROTECTION

- A. Do not permit traffic over finished floor surfaces for at least 4 days after installation is completed. Protect installed tile work as recommended by the manufacturer during construction to prevent damage.

END OF SECTION

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical tiles.
- C. Existing suspended ceiling tiles to be removed shall be recycled by the acoustic tile manufacturer. See Section 01 74 19 - Construction Waste Management and Disposal.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - Gypsum Board Assemblies: Drywall soffits.
- B. Division 21 - Fire Suppression.
- C. Division 23 - HVAC.
- D. Division 26 - Electrical.

1.03 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2013a.
- B. ASTM C636 - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2008.
- C. ASTM E580 - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2011.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.
- E. UL - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical tiles until after interior wet work is dry, to the greatest extent feasible.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Samples:
 - 1. Submit samples 4x4 inch minimum in size, of selected acoustical tiles.
 - 2. Submit samples 8 inches minimum long, of suspension system main runner.
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of Project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Tiles: Quantity equal to 5 percent of total installed.
 - 3. Extra stock shall match products installed and shall be packaged in protective covers for storage and identified with labels describing contents. Store as directed by the Owner. Send written notice to the Architect identifying the quantity and location of extra tile furnished. The tile shall not be used by the Contractor for corrective work during the warranty period.

1.06 QUALITY ASSURANCE

- A. Fire-Resistive Assemblies: Complete assembly listed and classified by UL (FRD) for the fire resistance indicated.
- B. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum fifteen years documented experience.
- C. Acoustical Tile Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum fifteen years documented experience.

1.07 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of no more than 70 percent prior to, during, and after acoustical unit installation. Acoustic materials shall reach room temperature and moisture content prior to installation. Operate ventilation system for not less than 48 hours beginning acoustical panel ceiling installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Panels:
 - 1. Basis of Design: Armstrong World Industries, Inc
 - 2. CertainTeed Corporation:
 - 3. USG:
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Suspension Systems:
 - 1. Same as for acoustical units.

2.02 ACOUSTICAL TILES

- A. Acoustical Tiles - General: ASTM E 1264, Class A.
- B. Acoustical Tile Type ACT-1, -2 & -3: Painted mineral fiber, ASTM E 1264 Type III,
 - 1. Size: As indicated on the Drawings.
 - 2. Thickness: 3/4 inches.
 - 3. Composition: Water felted.
 - 4. Light Reflectance: not less than 0.90.
 - 5. NRC: not less than 0.70
 - 6. Ceiling Attenuation Class (CAC): not less than 35.
 - 7. Joint: Tegular.
 - 8. Edge: Beveled.
 - 9. Surface Color: White.
 - 10. Product:
 - a. Ultima Tegular by Armstrong World Industries.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - 11. Suspension System: Exposed grid Type 1.
- C. Acoustical Tile Type ACT-4 & -5: Painted mineral fiber, ASTM E 1264 Type III,
 - 1. Size: As indicated on the Drawings.
 - 2. Thickness: 3/4 inches.
 - 3. Composition: Water felted.
 - 4. Light Reflectance: not less than 0.90.
 - 5. NRC: not less than 0.70
 - 6. Ceiling Attenuation Class (CAC): not less than 35.
 - 7. Joint: Tegular.
 - 8. Edge: Beveled.
 - 9. Surface Color: White.
 - 10. Surface Pattern: Non-directional fissured.
 - 11. Products:

- a. Ultima HRC by Armstrong World Industries.
12. Suspension System: Exposed grid Type 1.
- D. Acoustical Tile Type ACT-7: Painted mineral fiber, ASTM E 1264 Type III,
 1. Size: As indicated on the Drawings.
 2. Thickness: 7/8 inches.
 3. Composition: Water felted.
 4. Light Reflectance: not less than 0.86.
 5. NRC: not less than 0.85
 6. Ceiling Attenuation Class (CAC): not less than 32.
 7. Joint: Tegular.
 8. Edge: Beveled.
 9. Surface Color: Stone.
 10. Surface Pattern: Non-directional fissured.
 11. Products:
 - a. Calla 2824 by Armstrong World Industries.
 12. Suspension System: Exposed grid Type 1.
- E. Acoustical Tile Type ACT-8 & -9: Painted mineral fiber, ASTM E 1264 Type III.
 1. Size: As indicated on the Drawings.
 2. Thickness: 1 inches.
 3. Composition: Wet felted.
 4. Light Reflectance: not less than 0.90.
 5. NRC: not less than 0.95
 6. Edge: Beveled.
 7. Surface Color: White.
 8. Surface Pattern: Non-directional fissured.
 9. Products:
 - a. Optima Tegular by Armstrong World Industries.
 10. Suspension System: Exposed grid Type 1.
- F. Acoustical Tile Type ACT-1A: Rated highly scrubbable, Vinyl faced mineral fiber, ASTM E 1264 Type IV,
 1. Size: As indicated on the Drawings.
 2. Thickness: 3/4 inches.
 3. Composition: Wet felted.
 4. Light Reflectance: not less than 0.86.
 5. NRC: 0.70.
 6. Ceiling Attenuation Class (CAC): not less than 38.
 7. Edge: Square.
 8. Surface Color: White.
 9. Products:
 - a. Ultima Health Zone 1936 by Armstrong World Industries.
 10. Suspension System: Exposed grid Type 1.

2.03 SUSPENSION SYSTEMS

- A. Manufacturers:
 1. Same as for acoustical tiles.
- B. Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, and perimeter moldings as required.
- C. Exposed Steel Suspension System Type 1: Formed steel, commercial quality cold rolled; heavy-duty.
 1. Profile: Tee; 9/16 inch wide face.
 2. Construction: Double web.
 3. Finish: White painted.
 4. Products:

- a. Suprafine 9/16 by Armstrong World Industries, Inc..
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Specialty Exposed Aluminum Suspension Perimeter System: Extruded 6063-T5 aluminum; system perimeter braces as/if required; splice plates, clips and brackets as required.
- 1. Perimeter Trim Size: Height - 4 inches.
 - 2. Configurations: Straight.
 - 3. Finish: White.
 - 4. Product: Axiom Classic Trim by Armstrong World Industries, Inc.

2.04 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
 - 1. Hanger wire: Galvanized soft temper, pre-stretched steel wire, per ASTM A641, with yield strength of at least 3 times design load, but not less than 12-gage diameter.
- B. Perimeter Moldings: Same material and finish as grid, size suitable for suspension system and ceiling unit profile. Molding shall be suitable for use in fire-rated ceiling systems.
 - 1. At Exposed Grid: 7/8" L-shaped molding for mounting at same elevation as face of grid.
 - 2. At Expansion: 2" L-Shaped molding for mounting at same elevation as face of grid.
- C. Stiffening Brace: As manufactured by the suspension system manufacturer to provide grid stabilization.
- D. Other Accessories: As required, specifically designed for intended use with suspension components employed, in accordance with ASA specifications. Provide all special hardware required for fire-rated, sloped and vertical installations, as necessary to comply with applicable codes and standards of good practice.
- E. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.
- F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that layout of hangers will not interfere with other work.
- C. Any questions or conflicts shall be brought to the attention of the Architect prior to proceeding with the Work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C 636/C 636M, ASTM E 580/E 580M, and manufacturer's instructions and as supplemented in this Section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Locate system on room axis according to reflected plan.
- D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- E. Provide hanger clips during steel deck erection. Do not support ceiling directly from steel roof deck or tabs. Provide additional hangers and inserts as required. Connect hanger wires directly either to structure, or to inserts, eye screws or other devices that are secure and appropriate for the substrate. All hangers and supports shall be secured in such a way that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
- F. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Install hangers plumb. Angle hangers only where required to miss obstructions. Any non-plumb

hangers that result in horizontal forces shall be braced. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

- G. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three (3) tight turns. Secure bracing wire to ceiling suspension members and to supports with a minimum of four (4) tight turns.
- H. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance. Alternatively, install supplemental suspension members and hangers in the form of trapeze or equivalent devices, sized to support ceiling loads.
- I. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- J. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
 - 1. Provide supplemental supports for grid where cubicle curtain tracks and I.V. tracks are attached to grids shall support a vertical test load of 50 lbs without visible deflection or damage to supports and safely support moving loads.
- K. Do not eccentrically load system or induce rotation of runners.
- L. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
 - 2. Overlap corners.
- M. Provide additional hangers for the suspension system at each corner of light fixtures if independent support of fixtures is not required by Electrical documents. All light fixtures in excess of 56 lb shall be independently supported.
- N. Provide additional hangers for air terminal units or services weighing more than 20 lb but less than 56 lb in addition to positively attaching them to the ceiling suspension system. Units weighing more than 56 lb shall be independently supported to the building structure.
- O. Walls or partitions attached to ceiling systems shall be provided with lateral bracing independent of the ceiling system unless ceiling system to partition connections and bracing is engineered to support the reaction force of the partition from the prescribed loads applied perpendicularly to the partitions. Partition attachment to the ceiling system shall allow lateral movement of the ceiling system.
- P. Provide framing for recessed light fixtures, air outlets, diffusers, etc. See Architectural, Mechanical, and Electrical Drawings.
- Q. Expansion Joint Moldings: Install at intersection of ceilings and firewalls, building expansion joints, and where indicated on the Drawings.
- R. Form expansion joints as recommended by the manufacturer. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.
- S. Where approved by the Architect and where field conditions require lowering a portion of a ceiling to conceal piping or ductwork, the ceiling contractor shall provide a ceiling height change and transition at no additional cost to the Owner.

3.03 INSTALLATION - SUSPENSION SYSTEM SEISMIC REQUIREMENTS

- A. Provide suspension, bracing, and attachments in strict accordance with ASCE 7, current edition, ASTM C635, ASTM C636 and CISCA Recommendations For Direct-Hung Acoustical Tile and Lay-in Panel Ceilings, most recent edition. The requirements for seismic bracing shall generally include, but not be limited to the following features:
 - 1. For Seismic Design Categories A, B and C: CISCA requirements for Seismic Zones 0-2 and provisions in ASCE 7 Section 13.5.6.2.1.
 - a. For spaces less than 144 sq. ft. in size, no seismic restraint is required.
 - b. For spaces 144 sq. ft. and greater in size, in general provide:

- 1) The total weight of the suspension system (grid), tiles, and other ceiling components (light fixtures, air terminals, etc) shall be no greater than 2.5 PSF, or other ceiling components shall be independently supported.
- 2) The suspension system (grid) shall be designed, tested, and rated for ultimate load capacity as per ASCE 7.
- 3) All sides of the space shall have tees cut back 3/8" at the perimeter to accommodate movement and shall not be attached to the perimeter molding. Perimeter moldings shall provide a minimum supporting ledge of 7/8" for tees or all tees shall be independently supported within 8" of the perimeter. All ends of main runners and cross members shall be tied together or shall have stabilizer/spacer bars attached to members to prevent spreading. Permanent attachment (i.e. pop rivets) for grid alignment shall not be permitted.
- 4) Openings for sprinkler heads shall provide a minimum of 1/4" clearance on all sides of the piping. All other ceiling penetrations shall provide a minimum of 3/8" clearance.

3.04 INSTALLATION - ACOUSTICAL TILES

- A. Owner's Inspection: All areas above suspended ceilings shall be inspected by the Owner prior to installation of ceiling tiles. The Contractor shall obtain written permission from the Owner to proceed with ceiling tile installation. Failure to follow this procedure shall result in removal and reinstallation of ceiling panels to facilitate inspection at no additional cost to the Owner.
- B. Install acoustical tiles in accordance with manufacturer's instructions.
- C. Fit acoustical tiles in place, free from damaged edges or other defects detrimental to appearance and function.
- D. Lay directional patterned tiles with pattern parallel to longest room axis.
- E. Fit border trim neatly against abutting surfaces.
- F. Install tiles after above-ceiling work is complete. Do not install tile until mechanical and electrical systems are tested and complete and all firestopping and smoke seals have been inspected and accepted.
- G. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- H. Cutting Acoustical Tile:
 1. Cut to fit irregular grid and perimeter edge trim.
 2. Make field cut edges of same profile as factory edges.
 3. Double cut and field paint exposed reveal edges.
- I. Where round obstructions occur, provide preformed closures to match perimeter molding.

3.05 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

- A. Clean soiled exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members as recommended by the manufacturer. Remove and replace damaged ceiling components that cannot be successfully cleaned and repaired.

END OF SECTION

SECTION 09 65 00
RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Resilient tile flooring.
- C. Resilient base.
- D. Substrate patching and leveling as required.
- E. Slab-on-grade moisture vapor sealer.
- F. Installation accessories.
- G. Note: See ID Drawings for flooring pattern layouts.

1.02 RELATED REQUIREMENTS

- A. Section 01 23 00 - Alternates: Slab-on-grade sealer for excessive slab moisture vapor transmission.
- B. Section 01 40 00 - Quality Requirements: Concrete slab moisture testing.
- C. Section 03 54 00 - Cast Underlayment.

1.03 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2014c.
- B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
- C. ASTM F970 - Standard Test Method for Static Load Limit; 2007 (Reapproved 2011).
- D. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile; 2004 (Reapproved 2010)e1.
- E. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing; 2004 (Reapproved 2014).
- F. ASTM F1861 - Standard Specification for Resilient Wall Base; 2008 (Reapproved 2012)e1.
- G. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete SubFloor Using Anhydrous Calcium Chloride, 2011
- H. ASTM F 2170 - Standard Test method for Determining Relative Humidity of Concrete Slabs Using In-situ Probes.
- I. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; National Fire Protection Association; 2011.
- J. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; Resilient Floor Covering Institute; October 2011.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Shop Drawings: Indicate seaming plan for all sheet goods. All proposed seams shall be indicated. Installation shall not begin prior to the Architect's review and acceptance.
 - 1. Submit existing as-built verification of flooring patterns, game markings and graphics. This submittal shall be the basis of design for the installation of new flooring, striping and graphic layout and patterns.

- D. Verification Samples: Submit samples, 6 x 6 inch in size illustrating colors and patterns for each resilient flooring product specified.
- E. Concrete Testing:
 - 1. Substrate moisture testing shall be provided by the Owner. Flooring installation shall not begin until testing results are within flooring manufacturer's acceptable ranges.
- F. Certification and Field Reports:
 - 1. Prior to installation of flooring, submit written certification by each flooring manufacturer that condition of sub-floor is acceptable.
 - 2. Submit copies of manufacturer's technical representative's field reports for each field visit.
- G. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, and Section 01 78 00 - Project Close-out, for additional provisions.
 - 2. Extra Flooring Material: 45 square feet of each type and color.
 - 3. Extra Wall Base: 30 linear feet of each type and color.
 - 4. Extra Stair Materials: Quantity equivalent to 5 percent of each type and color.
 - 5. Materials shall be in provided in unbroken packaging when job is complete. Notify the Architect in writing of the quantity and location of materials furnished. These materials may not be used by the Contractor for corrective work during the warranty period.

1.05 QUALITY ASSURANCE

- A. All resilient flooring shall comply with ASTM E84 Flame Spread Rating of Class II (75 or less) and ASTM E662 Smoke Developed (450 or less) unless otherwise indicated.
- B. All vinyl composition products shall be by a single manufacturer.
- C. All colors shall match as directed by the Architect and shall be from the same "color run" or "dye lot".
- D. All adhesives shall be as recommended by the flooring product manufacturer and shall be formulated asbestos-free.

1.06 MOCK-UPS

- A. Construct mock-up for each type of flooring transition to include leveling and shimming products, flooring on both sides of the transition and transition strips. The Owner shall test each mock-up for ease of movement for wheeled equipment. Flooring transitions shall provide smooth, bump-free transitions to facilitate movement of wheeled equipment and minimize tripping hazards.
 - 1. Approved mock-ups may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING

- A. Convene a pre-installation meeting after the results of slab testing are available and at least two weeks before starting work of this Section; require attendance by the Contractor, a technical representative from each flooring manufacturer, flooring installer, Architect and Owner, to review slab moisture levels, floor surface conditions and preparation requirements, materials, installation procedures and coordination of related work.
 - 1. A field report summarizing the findings and recommendations from this meeting shall be issued by the technical representatives and copied to the Owner and Architect.
 - 2. Written certification from each flooring manufacturer that condition of sub-floor is acceptable for flooring installation shall be issued and copied to the Owner and Architect.
 - 3. If a slab sealer or other remedial work is required to make the condition of the sub-floor acceptable for the flooring installation, slab preparation and slab sealer product installation shall be field reviewed by the manufacturer's technical representatives and application tested (thickness, adhesion, etc) to confirm compliance with product recommendations.

1.08 DELIVERY, STORAGE, AND PROTECTION

- A. Protect roll materials from damage. Store roll material as directed by the manufacturer. All resilient flooring materials shall be stored in undamaged condition as packaged by the manufacturer, with manufacturer's seals and labels intact.

1.09 FIELD CONDITIONS

- A. Maintain temperature in storage area between 65 degrees F and 90 degrees F.
- B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

1.10 WARRANTY

- A. Provide manufacturer's product warranty. See product listing for term.

PART 2 PRODUCTS

2.01 SHEET FLOORING

- A. Vinyl Sheet Flooring Type SV-1: Slip-resistant; ASTM F1303, Type 2 Grade 1, Class A backing.
 - 1. Critical Radiant Flux, ASTM E648: Class 1.
 - 2. Smoke Developed, ASTM E662: Pass, 450 or less.
 - 3. Slip Resistance ASTM D2047: 0.85
 - 4. Static Load Limit, ASTM F970: 2500 psi.
 - 5. Total Thickness: 2.0 mm.
 - 6. Heat welded seams.
 - 7. Sheet Width: 144 inches.
 - 8. Colors/Patterns: See Finish Legend.
 - 9. Warranty: Ten years.
 - 10. Products:
 - a. Suprema by Altro.
 - b. Substitutions: See Section 01 60 00 - Product Requirements
- B. Vinyl Sheet Flooring Type SV-2: Slip-resistant; ASTM F1303, Type 2 Grade 1, Class A backing.
 - 1. Critical Radiant Flux, ASTM E648: Class 1.
 - 2. Smoke Developed, ASTM E662: Pass, 450 or less.
 - 3. Slip Resistance ASTM D2047: 0.85
 - 4. Static Load Limit, ASTM F970: 4000 psi.
 - 5. Total Thickness: 2.34 mm.
 - 6. Heat welded seams.
 - 7. Sheet Width: 72 inches.
 - 8. Colors/Patterns: See Finish Legend.
 - 9. Warranty: Ten years.
 - 10. Products:
 - a. Oak Collection by Technoflor
 - b. Substitutions: See Section 01 60 00 - Product Requirements
- C. Vinyl Sheet Flooring Type SV-3: Wood-look; ASTM F 1303, Type I; PVC wear layer, design layer, glass fiber reinforced under-layer.
 - 1. Critical Radiant Flux, ASTM E648: Class 1; minimum 0.45 watt per sq cm.
 - 2. Smoke Generation, ASTM E662: Pass, 450 or less.
 - 3. Wear Layer: 0.05 mm.
 - 4. Total Thickness: 2.2 mm.
 - 5. Sheet Width: 108 inches
 - 6. Static Load Limit, ASTM F970:
 - 7. Heat welded seams.
 - 8. Colors/Patterns: See Finish Legend.

9. Warranty: Ten years.
10. Products:
 - a. Realities by Mannington.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Vinyl Sheet Flooring Type SV-4: ASTM F 1303, Type I; Class A.
 1. Critical Radiant Flux, ASTM E648: Class 1; minimum 0.45 watt per sq cm.
 2. Smoke Generation, ASTM E662: Pass, 450 or less.
 3. Wear Layer: 0.020 mm.
 4. Total Thickness: 0.080 mm.
 5. Sheet Width: 144 inches
 6. Static Load Limit, ASTM F970:
 7. Heat welded seams.
 8. Colors/Patterns: See Finish Legend.
 9. Warranty: Ten years.
 10. Products:
 - a. Insight Plus by Mannington
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Rubber Sheet Flooring Type RF-1 & 1A: 100% rubber composition, homogenous color and pattern.
 1. Critical Radiant Flux, ASTM E648: Class 1, minimum 0.45 watt per sq cm.
 2. Smoke Developed, ASTM E662: Pass, less than 450.
 3. VOC Content: Certified as Low Emission.
 4. Sheet Total Thickness: 4 mm.
 5. Sheet Width: 48 inches.
 6. Static Load Limit, ASTM F790: 800 lbs residual compression 0.005 inches.
 7. Colors: See Finish Legend.
 8. Welded seams.
 9. Warranty: 5 years.
 10. Products:
 - a. Atmosphere by To Market
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Vinyl Welding Rod: Solid vinyl bead produced by flooring manufacturer for heat welding seams, vinyl to vinyl, in color matching field color.

2.02 TILE FLOORING

- A. Vinyl Composition Tile Type VCT-1 ASTM F1066, Class 2.
 1. Critical Radiant Flux: Minimum 0.45 watt per sq cm per ASTM E 648.
 2. Smoke Developed, ASTM E662: Pass, 450 or less.
 3. Static Load Limit, ASTM F970: 125 psi min.
 4. Size: 12 by 12 inch.
 5. Thickness: 0.125 inch..
 6. Colors / Patterns: See Finish Schedule.
 7. Products:
 - a. Progressions by Mannington Commercial
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Vinyl Tile Type LVT-1: Slip-resistant; Printed film type, with transparent or translucent wear layer; ASTM F1700 Class II Type B.
 1. Critical Radiant Flux: Class 1, minimum 0.45 watt per sq cm per ASTM E648.
 2. Static Load Limit, ASTM F970: 125 psi.
 3. Tile Size: 12 by 12 inch.
 4. Wear Layer Thickness with grit: 0.030 inch.
 5. Total Thickness: 0.120 inch.
 6. Warranty: 20 years.

7. Colors and Patterns: See Finish Legend.
8. Products:
 - a. Event Stone by Centiva
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 STAIR COVERINGS

- A. Stair Treads with Integral Risers Type ST-1: Vinyl; FS RR-T-650; nosing not less than 1-5/8 inch deep.
 1. Critical Radiant Flux, ASTM E648: Class 1, minimum 0.45 watt per sq cm.
 2. Size: Full width and depth of stair tread in one piece. Provide equal length units for stairs exceeding manufacturer's maximum manufactured lengths.
 3. Nominal Thickness: 0.1875 inch.
 4. Nosing: Square.
 5. Surface Profile: Hammered.
 6. Style: Contrasting color nosing strip.
 7. Colors: See Finish Legend.
 8. Products:
 - a. Visually Impaired by Johnsonite
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 RESILIENT BASE

- A. Resilient Base Type VB-1, 2 & 5: Type TV, vinyl, thermoplastic; PVC; pre-molded outside corners.
 1. Provide cove base at resilient flooring.
 2. Provide straight base at carpet.
 3. Fire Resistance, ASTM E84: Class B.
 4. Critical Radiant Flux, ASTM E648: Class 1, Minimum 0.45 watt per sq cm.
 5. Height: 4.5 inches and as indicated on the Finish Legend.
 6. Thickness: 0.25 inch thick.
 7. Finish: Satin.
 8. Length: Roll.
 9. Colors: See Finish Legend.
 10. Warranty: Two years.
 11. Products:
 - a. Tightlock by Johnsonite
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Resilient Base Type VB-3: Vinyl, thermoplastic; Rubber; pre-molded outside corners.
 1. Critical Radiant Flux, ASTM E648: Class 1, Minimum 0.45 watt per sq cm.
 2. Height 4.25 inches.
 3. Thickness: .375 inches.
 4. Finish: Satin.
 5. Length: 8 feet.
 6. Colors: See Finish Legend.
 7. Warranty: One year.
 8. Products:
 - a. Perceptions Recess by Johnsonite
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Resilient Base Type VB-4: Type TV, vinyl, thermoplastic; PVC; field-made outside corners.
 1. Provide cove base at resilient flooring.
 2. Fire Resistance, ASTM E84: Class B.
 3. Critical Radiant Flux, ASTM E648: Class 1, Minimum 0.45 watt per sq cm.
 4. Height: 4 inches and as indicated on the Finish Legend.
 5. Thickness: 0.125 inch thick.
 6. Finish: Satin.

7. Length: Roll.
8. Colors: Color as selected from manufacturer's standards.
9. Warranty: Two years.
10. Products:
 - a. Tradition Vinyl Wall Base by Johnsonite, Inc.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORIES

- A. Subfloor Patching Compounds: Cementitious type recommended by adhesive material manufacturer and flooring manufacturer. Calcium sulphate, plaster or gypsum based toppings, leveling and patching compounds are not acceptable.
 1. Slope / Build-up Product: SD-P by Ardex.
- B. Self-Leveling Underlayment: Portland cement-based self-leveling underlayment.
 1. Substrate preparation and conditions shall be reviewed and confirmed with the manufacturer's technical representative prior to installation.
 2. Slab primer as recommended by the underlayment manufacturer.
 3. Self-leveling Underlayment Strength, ASTM C109: 4000 psi minimum, 28 days.
 4. Products:
 - a. K-15 by Ardex.
 - b. Standard SLU by Chapco, a division of H.B. Fuller.
- C. Self-Leveling Underlayment: See Section 03 54 00 - Cast Underlayment.
- D. Slab Moisture Barrier System: Epoxy slab coating for moisture vapor remediation and primer coat. System shall be surfaced with a self-leveling cementitious underlayment for resilient finish flooring.
 1. Moisture Vapor Control Coating: VOC regulation compliant; Low odor.
 - a. VOC content <10 g/l
 2. Substrate preparation and conditions shall be reviewed and confirmed with the manufacturer's technical representative prior to installation.
 3. Warranty:
 - a. Koster; 15 years.
 4. Products:
 - a. VAP I 2000 coating, VAP I 06 primer by Koster.
 - b. Defender coating, MP Primer by Chapco, a division of H.B. Fuller.
 - c. AquArmor MCS by General Polymers - Sherwin Williams.
 - d. Moisture Limiter by Forbo.
- E. Scribing Felt: As recommended by the flooring manufacturer.
- F. Primers, Adhesives, and Seaming Materials: Waterproof; low VOC types recommended by flooring manufacturers.
- G. Flooring Transitions:
 1. At resilient flooring to resilient flooring transition:
 - a. Where existing flooring is thicker than proposed: No transition strip. Use scribing felt at unequal thickness products.
 - b. Where proposed flooring is thicker than existing: Vinyl transition strip.
 2. At ceramic tile flooring to resilient flooring transitions: Adjust substrate surface for resilient flooring surface to match top of ceramic tile. Use metal transition.
 3. At carpet to resilient flooring or other transitions: Use vinyl transition strips and as otherwise required for a complete and proper job.
 4. Colors and Finishes: Selected by architect from manufacturer's standard.
 5. Products:
 - a. Metal: Configurations to suit job conditions, subject to Architect's prior review.
 - 1) Schuler.
 - b. Vinyl: Configurations to suit job conditions, subject to Architect's prior review.
 - 1) Wheeled Traffic Transitional Mouldings by Johnsonite, Inc.

- H. Filler for Coved Base: Plastic.

PART 3 EXECUTION

3.01 GENERAL

- A. Floor tile pattern layouts shall be as designed by the Architect. Flooring shall be placed so that fields or patterns center on area. The Architect shall select the pattern (direction of grain) to be used.
- B. For renovations, thoroughly inspect all of the Contract Documents and provide resilient flooring and base patching to match existing adjacent materials throughout the building.
- C. Base shall be continuous as scheduled unless otherwise approved by the Architect. Base shall return to door or window frames at all openings.
- D. Unless otherwise approved by the Architect, flooring materials shall extend below fixed casework and millwork to cover the entire floor areas. Where integral base is provided, it shall extend behind casework to form a watertight base.
- E. Work shall not be started until work of other trades, which goes through resilient flooring, has been completed.
- F. Thoroughly clean the flooring substrate.

3.02 EXAMINATION AND FIELD TESTING

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
 - 1. Concrete Slabs: Verify substrate conforms to ASTM F710. Perform adhesive bond tests and water absorption tests.
- B. Cementitious Subfloor Surfaces: Verify that substrate conforms to ASTM F710.
 - 1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- C. Owner's testing agency shall test concrete slab surfaces prior to installation of any flooring. Test results shall be made available to the contractor for determination of acceptability by the flooring and adhesives manufacturers. Contractor shall obtain instructions from flooring manufacturers if test results are not within their recommendation limits. Test results shall be submitted to the Owner and Architect for record. Testing shall include:
 - 1. Internal relative humidity rates per ASTM F2170
 - 2. Alkalinity, pH rates per ASTM 710.
- D. If remedial work is recommended by the flooring and adhesive manufacturers, the preparation for and installation of moisture control coatings shall be inspected by the product manufacturer's technical representative and tested for adequacy by the Contractor's testing agency prior to resumption of the flooring installation.
- E. Any conditions that could adversely affect the flooring installation shall be corrected, prior to proceeding with the Work. Commencement of the installation of flooring shall be considered acceptance of the concrete slab as being suitable for the intended application. Any conditions that could adversely affect the flooring installation shall be brought to the Contractor's attention, for resolution, prior to proceeding with the Work.

3.03 PREPARATION

- A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI Recommended Work Practices for Removal of Resilient Floor Coverings.
- B. Prepare subfloor surfaces as recommended by flooring and adhesive manufacturers.
- C. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor patching compound to achieve smooth, flat, hard surface. Provide

transition strips directly over construction joints between new and existing floor slabs where applicable.

- D. Resilient flooring shall not be installed over floors that have been treated with chemical compounds. Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by the manufacturer. Do not use solvents.
- E. Subfloor surfaces shall not vary more than plus or minus 1/8" in any 10' dimension. Neither shall they vary at a rate greater than 1/16" per running foot. Leveling compound shall be used for larger areas.
 - 1. For subfloor surfaces intended to slope to floor drains, build-up product shall be installed precisely to create proper pitch. Floor pitch shall be laser verified with results submitted to the Architect and Owner.
- F. All flooring surface transitions shall be as smooth and level as possible. Resilient flooring shall be laid flush with all adjacent flooring materials. Fill edge of subfloor adjacent to higher flooring with approved crack and leveling filler as required to provide a smooth transition. Filler shall be feathered back to subfloor a minimum of one foot for each 1/16" of thickness.
- G. Prohibit traffic until filler is cured.
- H. Clean substrate.

3.04 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install terminations as identified above. In general, flooring substrates shall be shimmed to provide a level transition between flooring surfaces without transition strips.
- H. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- I. Scribe flooring to walls, columns and other appurtenances to produce tight joints.

3.05 SHEET FLOORING

- A. Lay flooring in accordance with accepted seaming shop drawings.
- B. Flooring shall be laid continuously wall-to-wall, without joints, unless specifically accepted by the Architect prior to installation.
- C. In general, lay flooring with seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns carefully at seams.
- D. Double cut sheet at seams.
- E. Lay flooring with tightly butted seams, without any seam sealer unless otherwise indicated.
- F. Finish sheet flooring seams by heat welding.

3.06 TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer's instructions say otherwise. Lay tile in pattern and grain direction as directed by the Architect.
- B. Lay flooring with joints and seams parallel to building lines to produce symmetrical tile pattern.

3.07 RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints. Install wall base in lengths as long as without gaps at seams and with tops of adjacent pieces aligned. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- B. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold. Provide pre-molded external corners where specified. Special attention shall be paid to firmly securing base around bull nose corners.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.08 STAIR COVERINGS

- A. Stairs shall be filled with crack and leveling filler as required to properly form and level. Fill and grind tread and nosings as required.
- B. Install stair coverings in one piece for full width and depth of tread. A full depth tread shall be provided for the top nosing of all stairs.
- C. For stair widths that exceed the maximum manufactured length of treads, splice locations shall be reviewed with and approved by the Architect.
- D. Top edges of stair risers shall be "tucked" 1/8" (minimum) behind bottom edges of stair tread nosings. Both edges shall be firmly cemented into place. Special attention shall be paid to ensuring that nosings are tightly fitted and secure.
- E. Adhere over entire surface. Fit accurately and securely.

3.09 FIELD QUALITY CONTROL

- A. Manufacturer's Inspections: Following the requirements for pre-installation field meeting and sub-floor preparations for the flooring installation, inspections shall be made by technical representatives of each flooring system manufacturer at the following points in the flooring installation:
 - 1. First, during demolition of existing flooring and preparation of subfloor surfaces. And upon completion of subsurface remediation procedures, if such remediation's are required. Manufacturer to provide written verification that subsurface conditions meet manufacturer requirements.
 - 2. Second, early in the installation process to ascertain that flooring procedures and details discussed at the pre-construction meeting are being followed.
 - 3. Third, at the completion of the installation, to review the completed installation. Manufacturer's technical representative's field reports for each site visit shall be copied to the Owner and Architect.
- B. Bond testing shall be performed on Techno Flooring at a rate of one per 50 sq ft by the flooring contractor. Submit test results to the Owner, Architect and flooring manufacturer.

3.10 CLEANING

- A. Immediately after installation, remove excess adhesive and other blemishes from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's instructions.

3.11 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation. Protect flooring against marks and damage from construction operations utilizing methods recommended by the flooring manufacturer. Cover tiles with undyed building paper until inspection for Substantial Completion.

END OF SECTION

SECTION 09 68 00
CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet, stretched-in with cushion underlay and direct-glued.
- B. Removal of existing carpet.
- C. Accessories. NOTE: All flooring transitions shall provide smooth floor surfaces, with no abrupt elevation change.

1.02 RELATED REQUIREMENTS

- A. Section 01 23 00 - Alternates: Slab-on-grade sealer for excessive slab moisture vapor transmission.
- B. Section 01 40 00 - Quality Requirements: Concrete slab moisture testing.
- C. Section 01 74 19 - Construction Waste Management: Reclamation/Recycling of new carpet scrap, new cushion scrap, removed carpet, and removed carpet cushion.
- D. Section 03 54 00 - Cast Underlayment.
- E. Section 09 65 00 - Resilient Flooring: Base finish. Concrete slab moisture testing.

1.03 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2006 (Reapproved 2011).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2014c.
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
- D. CRI - Carpet Installation Standard; Carpet and Rug Institute; 2009.
- E. CRI - Green Label Testing Program - Approved Product Categories for Carpet; Carpet and Rug Institute; Current Edition.
- F. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; National Fire Protection Association; 2011.
- G. NFPA 258 - Standard Method of Test for Smoke Density

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate seaming plan, method of joining seams, direction of carpet pile and pattern, location of edge moldings and edge bindings. No carpet shall be ordered until shop drawings have been reviewed by the Architect.
- C. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- D. Samples:
 - 1. Submit samples 18" x 24" inch in size illustrating color and pattern for each carpet material specified.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- F. Certification and Field Reports:
 - 1. Prior to installation of flooring, submit written certification by each flooring manufacturer that condition of sub-floor is acceptable.
 - 2. Submit copies of manufacturer's technical representative's field reports for each field visit.

- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional requirements.
 - 2. Extra Carpet: 100 sq ft of each type, color, and pattern installed.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in commercial carpet installations with minimum five years experience.
- C. All carpet shall meet or exceed the Carpet and Rug Institute's Indoor Air Quality labeling standards and shall bear labeling indicating compliance with these standards. Under these standards, volatile organic compounds given off by carpets shall be less than 0.6 milligrams per square meter per hour.

1.06 MOCK-UPS

- A. Construct mock-up for each type of flooring transition to include leveling and shimming products, flooring on both sides of the transition and transition strips. The Owner shall test each mock-up for ease of movement for wheeled equipment. Flooring transitions shall provide smooth, bump-free transitions to facilitate movement of wheeled equipment and minimize tripping hazards.
 - 1. Approved mock-ups may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING

- A. Convene a pre-installation meeting at least two weeks before starting work of this Section; require attendance by the Contractor, a technical representative from each carpet manufacturer, carpet installer, Architect and Owner, to review slab moisture levels, floor surface conditions and preparation requirements, materials, installation procedures and coordination of related work.
 - 1. A field report summarizing the findings and recommendations from this meeting shall be issued by the technical representatives and copied to the Owner and Architect.
 - 2. Written certification from each carpet manufacturer that condition of sub-floor is acceptable for flooring installation shall be issued and copied to the Owner and Architect.

1.08 FIELD CONDITIONS

- A. Comply with the CRI Manual regarding the storage and handling of carpet products. Store materials in area of installation for minimum period of 24 hours prior to installation.
- B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.
- C. Ventilate installation area during installation and for 72 hours after installation.

1.09 WARRANTY

- A. All carpet which exhibits abnormal wear, aging, discoloration or deterioration for a period of not less than three (3) years from the date of Substantial Completion shall be repaired or replaced at no additional cost to the Owner. Such warranty shall be extended beyond three (3) years consistent with the customary practice of the manufacturer.
- B. The installer shall be required to re-lay, re-stretch, or replace all carpet that does not provide an attractive, wrinkle-free appearance or which exhibits open seams, loss of adhesion or other installation defects for a period of one (1) year from the date of Substantial Completion.

1.10 OWNER TRAINING

- A. A carpet cleaning and maintenance training session for the Owner shall be held at the completed facility conducted by a qualified representative of the carpet manufacturer. Printed carpet maintenance instructions shall be provided to the Owner in advance of the training session.

PART 2 PRODUCTS

2.01 CARPET

- A. Carpet, Type CPT-1:
 - 1. Product: Equilibrium 30400 by Tandus Centiva.
 - 2. Roll Width: 12 ft.
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 1/10, 39.4 rows/10 cm
 - 5. Yarn Type: Loop.
 - 6. Yarn Weight/Sq. Yd.: 24 oz/sq yd
 - 7. Dye Method: Dynex 74% Solution Dyed/26% Space Dyed
 - 8. Pile Height: 0.157 inch
 - 9. Backing: Primary polypropylene and Secondary Ergostep High Density Polyurethane Cushion
 - 10. Warranty: 10 Year Limited
 - 11. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 12. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").
- B. Carpet, Type CPT-2, -5 & -7:
 - 1. Product: Minimalist Broadloom (6552) by J & J Invasion
 - 2. Roll Width: 12 ft.
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 1/12, 4.72 rows/cm
 - 5. Yarn Type: Loop.
 - 6. Yarn Weight/Sq. Yd.: 22 oz/sq yd
 - 7. Dye Method: Solution Dyed
 - 8. Backing: Primary TitanBac Plus with ProSept antimicrobial.
 - 9. Warranty: Limited Lifetime
 - 10. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 11. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").
- C. Carpet, Type CPT-3, -6 & -8:
 - 1. Product: Danish Modern Broadloom (6553) by J & J Invasion
 - 2. Roll Width: 12 ft.
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 1/12, 4.72 rows/cm
 - 5. Yarn Type: Loop.
 - 6. Yarn Weight/Sq. Yd.: 23 oz/sq yd
 - 7. Dye Method: Solution Dyed
 - 8. Backing: Primary TitanBac Plus with ProSept antimicrobial.
 - 9. Warranty: Limited Lifetime
 - 10. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 11. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").
- D. Carpet, Type CPT-4:
 - 1. Product: Spectrum V30 by Mohawk Group - Bigelow
 - 2. Roll Width: 12 ft.
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 1/10, 39.37 rows/10 cm
 - 5. Yarn Type: Loop.
 - 6. Yarn Weight/Sq. Yd.: 30 oz/sq yd
 - 7. Dye Method: Piece Dyed
 - 8. Backing: ActionBac.
 - 9. Warranty: Limited Lifetime
 - 10. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 11. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").

- E. Carpet, Type CPT-9:
 - 1. Product: Boulevard (2017) by J & J Invasion
 - 2. Roll Width: 12 ft.
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 1/12, 4.72 rows/cm
 - 5. Yarn Type: Loop.
 - 6. Yarn Weight/Sq. Yd.: 23 oz/sq yd
 - 7. Dye Method: Solution Dyed
 - 8. Backing: Primary TitanBac Plus with ProSept antimicrobial.
 - 9. Warranty: Limited Lifetime
 - 10. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 11. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").
- F. Carpet, Type CPT-10:
 - 1. Product: Scena by Mannington
 - 2. Roll Width: 12 ft 6 inch
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 5/64
 - 5. Yarn Type: Loop.
 - 6. Yarn Weight/Sq. Yd.: 21 oz/sq yd
 - 7. Dye Method: Solution Dyed
 - 8. Backing: UltraBAC RE
 - 9. Warranty: Limited Lifetime
 - 10. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 11. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").
- G. Carpet, Type CPT-11:
 - 1. Product: Craftsman (6555) by J & J Invasion
 - 2. Roll Width: 12 ft.
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 1/12, 4.72 rows/cm
 - 5. Yarn Type: Loop.
 - 6. Yarn Weight/Sq. Yd.: 23 oz/sq yd
 - 7. Dye Method: Solution Dyed
 - 8. Backing: Primary TitanBac Plus with ProSept antimicrobial.
 - 9. Warranty: Limited Lifetime
 - 10. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 11. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").
- H. Carpet, Type CPT-12:
 - 1. Product: Get Real II by Mohawk Group - Bigelow
 - 2. Roll Width: 12 ft.
 - 3. Patten / Color: See Finish Legend.
 - 4. Gauge: 1/8, 31.50 rows/10 cm
 - 5. Yarn Type: Cut and Loop.
 - 6. Yarn Weight/Sq. Yd.: 30 oz/sq yd
 - 7. Dye Method: Piece Dyed
 - 8. Backing: Weldlok
 - 9. Warranty: Limited Lifetime
 - 10. Critical Radiant Flux, ASTM E648 or NFPA 253: Minimum of 0.22 watts/sq cm.
 - 11. Surface Flammability Ignition, ASTM D2859: Pass ("pill test").

2.02 ACCESSORIES

- A. Sub-Floor Filler and Leveler: See Section 09 65 00 and as recommended by flooring manufacturer.
- B. Flooring Transitions: See Section 09 65 00.

- C. Contact Adhesive: As recommended by the flooring manufacturer. Compatible with carpet material; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Acceptance by Carpet Subcontractors: The carpet installer shall inspect the condition of substrates prior to commencement of work and shall notify the Contractor immediately of any conditions that could adversely affect the carpet installation for resolution, prior to proceeding with the Work. Commencement of the installation of flooring without such notification shall be considered acceptance of the adequacy of the substrates and carpet installation environment as being suitable for the intended application
- B. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive carpet.
- C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesives to sub floor surfaces.
- D. Owner's testing agency shall verify concrete subfloor or self-leveling underlayment surface moisture emission rates and alkalinity prior to installation of any flooring. Test results shall be made available to the contractor for determination of acceptability by the flooring and adhesives manufacturers. Contractor shall obtain instructions from flooring manufacturers if test results are not within their recommendation limits.
 - 1. Internal relative humidity rates per ASTM F2170
 - 2. Moisture vapor emission rates per ASTM F1869.
 - 3. Alkalinity, pH rates per ASTM 710.
 - 4. Adhesive bond tests.
 - 5. Water absorption tests.
- E. If remedial work is recommended by the flooring and adhesive manufacturers, the preparation for and installation of moisture control coatings shall be inspected by the product manufacturer's technical representative and tested for adequacy by the Owner's testing agency prior to resumption of the flooring installation
- F. Field check all dimensions and other conditions to ensure proper fitting of carpet.
- G. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Remove existing carpet and carpet cushion.
- B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- C. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
- D. Carpet shall be laid flush with adjacent flooring materials. Fill edge of sub-floor adjacent to higher flooring with approved leveling filler as required to provide a smooth transition. Filler shall be feathered back to subfloor a minimum of one foot for each 1/16" of thickness. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- E. Clean substrate.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet and cushion in accordance with manufacturer's instructions.
- C. Do not begin installation until all unsatisfactory substrate conditions have been corrected and the work of other trades, including painting, has been completed. Comply with the carpet manufacturer's written installation instructions for preparing substrates and carpet installation.

- D. All incompatible substances shall be removed. Substrates shall be dry and thoroughly cleaned, ground or filled as required. Apply surface sealer if recommended by carpet manufacturer.
- E. Verify carpet match before cutting to ensure minimal variation between dye lots.
- F. Lay out carpet and locate seams in accordance with shop drawings.
 - 1. Locate seams in area of least traffic, out of areas of pivoting traffic, and parallel to main traffic.
 - 2. Do not locate seams perpendicular through door openings.
 - 3. Align run of pile in same direction as anticipated traffic and in same direction on adjacent pieces.
 - 4. Locate change of color or pattern between rooms under door centerline.
 - 5. Provide monolithic color, pattern, and texture match within any one area.
- G. Install carpet tight and flat on subfloor, well fastened at edges, with a uniform appearance.
- H. Extend carpeting into adjoining closets and alcoves unless otherwise indicated on the Drawings.
- I. Do not bridge building expansion joints with carpet.

3.04 DIRECT-GLUED CARPET

- A. Double cut carpet seams, with accurate pattern match. Make cuts straight, true, and unfrayed. Apply seam adhesive to cut edges of woven carpet immediately.
- B. Apply contact adhesive to floor uniformly at rate recommended by manufacturer. After sufficient open time, press carpet into adhesive.
- C. Apply seam adhesive to the base of the edge glued down. Lay adjoining piece with seam straight, not overlapped or peaked, and free of gaps.
- D. Roll with appropriate roller for complete contact of adhesive to carpet backing.
- E. Trim carpet neatly at walls and around interruptions.
- F. Provide continuous resilient base where ever scheduled or indicated. Provide carpet edge strips or joiners wherever carpet abuts a dissimilar floor materials. Complete installation of edge strips, concealing exposed edges. See Section 09 65 00 - Resilient Flooring.

3.05 CLEANING AND PROTECTION

- A. Remove excess adhesive from floor and wall surfaces without damage. Remove yarns that protrude from carpet surface.
- B. Clean and vacuum carpet surfaces using a commercial machine with face-beater element. Clean again immediately prior to final acceptance.
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of the construction period. Use protection methods recommended in writing by the carpet manufacturer.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. All necessary surface preparation.
- B. Field application of paints.
- C. Scope: Finish all interior surfaces exposed to view, unless fully factory-finished.
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Elevator pit ladders.
 - 3. Exposed surfaces of steel lintels and ledge angles.
 - 4. Prime surfaces to receive wall coverings.
 - 5. Mechanical and Electrical:
 - a. In finished areas, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. In finished areas, paint shop-primed items.
 - c. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 - d. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Roofing and flashing.
 - 6. Marble, granite, slate, and other natural stones.
 - 7. Floors, unless specifically so indicated.
 - 8. Ceramic and other tiles.
 - 9. Glass.
 - 10. Acoustical materials, unless specifically so indicated.
 - 11. Concealed pipes, ducts, and conduits.
- E. Surface preparation, patching and repainting of existing interior walls, partitions, and ceilings disturbed by the Work, as indicated on the Drawings or as otherwise required.
- F. Field testing for substrate moisture content and alkalinity.
- G. Field testing compatibility of new paint with shop-applied primers, existing paint or finishes to be covered.
- H. Verification of compatibility of shop primers (mechanical equipment, structural steel, steel fabrications, etc.) with finish coatings specified herein.
- I. Fireproof coating for steel lintels greater than 6 feet in length supporting load bearing masonry walls.
- J. The painting subcontractor shall examine all the Sections of the Specifications and shall thoroughly familiarize himself with all their provisions regarding painting and finishing.

1. All surfaces that are primed or left unfinished by the requirements of other Sections of the Specifications shall be painted or finished as a part of this Section, unless specifically indicated otherwise.
 2. Areas of new patches in existing construction shall be painted or finished, and where not scheduled, shall match the existing finish.
- K. Finish Schedule: Refer to the Interior Design Drawings, Finish Legend and Schedule for color selections and product types.

1.02 RELATED REQUIREMENTS

- A. Section 05 12 00 - Structural Steel: Shop-primed items.
- B. Section 05 50 00 - Metal Fabrications: Shop-primed items.
- C. Section 05 51 00 - Metal Stairs: Shop-primed items.
- D. Section 06 20 00 - Finish Carpentry: Shop-finished hardwood millwork.

1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2012.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.
- D. GreenSeal GS-11 - Paints; 2013.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
 1. Where sheen is specified, submit samples in only that sheen.
 2. Allow 30 days for approval process, after receipt of complete samples by Architect.
- C. Product Data: Submit data on all finishing products, including VOC content. List each product and cross-reference it to the specification's Part 2, Products.
- D. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.
- E. Manufacturer's Instructions: Indicate special surface preparation procedures.
- F. Maintenance Manual: Provide a paint and coatings maintenance manual including area summary with finish schedule, area detail designating location where each product, color, finish was used, product data pages, MSDS sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.
- G. Following the satisfactory completion of all painting, the Contractor shall prepare and submit to the Architect typed copies of a complete list of all materials and colors used for the Work. This list shall be sufficiently clear and complete for the Owner's use in purchasing materials required for touch-up and repainting.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the work of this Section with minimum five years experience and shall have completed similar painting system applications with a record of successful in-service performance.
- B. Material Data Sheet product information for all painting products shall be kept on file on the job site before work begins.
- C. All materials shall be thoroughly stirred. No materials shall be reduced or changed in any way. Any tinting or matching of colors shall be done to the satisfaction of the Architect. In all cases a sample shall be applied on the job and Architect must approve before work is actually begun. Execute work in accordance with manufacturer's printed instructions.

1.06 REGULATORY REQUIREMENTS

- A. For Maine projects, all field applied paints and coatings shall meet state VOC standards.

1.07 MOCK-UP

- A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
- B. Provide a finished sample room, complete or in part, with all finish items completed in accordance with the Specification and in selected colors. Items not accepted shall be re-finished. When accepted, they shall serve as a standard for workmanship, appearance and materials for similar areas throughout this Project.
- C. Accepted mock-ups may remain as part of the Work.

1.08 PRE-INSTALLATION MEETING

- A. A pre-installation meeting shall be held at the jobsite, including: Contractor, painting subcontractor, paint manufacturer's technical representative, Owner's representative and Architect. The purpose of the meeting shall be to review existing conditions. The paint manufacturer's technical representative shall perform an on-site inspection to confirm compatibility and suitability of specified materials, following which he shall provide written certification that all materials specified are entirely suitable for their proposed applications.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in manufacturer's sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- D. Store all materials used on the job in a single place. Keep storage place neat, dry and clean. All soiled or used rags, waste and trash must be removed from the building every night, and every precaution taken to avoid the danger of fire. All materials shall be protected from freezing.

1.10 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.
- F. The Owner and all subcontractors shall be kept informed of the use of products that may generate fumes in advance of the use of such products.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
- B. Paints:
 - 1. Basis of Design: Sherwin Williams Co.
 - 2. Acceptable Manufacturers:

- a. Benjamin Moore & Co.
- b. PPG Architectural Finishes, Inc.
- c. Tnemec Coatings.

C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND COATINGS - GENERAL

- A. All materials used on the Work shall be as specified in brand and quality. No claims as to unsuitability or unavailability of any materials specified, or unwillingness to use same, or inability to produce first class work with same, will be entertained unless such claims are made in writing and submitted prior to the receipt of proposals.
- B. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 3. Supply each coating material in quantity required to complete entire project's work from a single production run.
 4. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- C. Primers: As follows unless other primer is required or recommended by manufacturer of top coats; where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- D. Volatile Organic Compound (VOC) Content:
 1. Provide coatings that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Architectural coatings VOC limits of State in which the project is located.
 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- E. Colors: As indicated on drawings
 1. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Ferrous Metals, light duty, Acrylic, 3 Coat:
 1. Primer 1st coat; SW ProCryl Universal Primer, B66-310. 2-4 mils DFT.
 2. Gloss: 2nd and 3rd coats; SW Sher-Cryl High Performance Acrylic B66-300.2.5-4 mils DFT/coat.
- B. Galvanized Metals, heavy duty, Acrylic, 3 Coat:
 1. Primer 1st coat; SW Pro-Cryl Universal Acrylic Primer B66-310. 2-4 mils DFT.
 2. Semi-gloss: 2nd and 3rd coats; SW Sher-Cryl HPA Acrylic B66-350.2.5-4 mils DFT/coat.

2.04 PAINT SYSTEMS - INTERIOR

- A. Wood: Opaque, Latex, 3 Coat:
 1. Primer 1st coat ; SW Harmony Interior Latex Primer. 1.6 mil DFT.
 2. Semi-gloss: 2nd and 3rd coats; SW Harmony Low Odor Latex B10-500 Series, 1.6 mils DFT/coat.
 3. Eggshell: 2nd and 3rd coats; SW Harmony Low Odor Latex; B09-500 Series, 1.8 mils DFT/coat.
 4. Flat: 2nd and 3rd coats; SW Harmony Low Odor Latex; B5-700 Series. 1.8 mils DFT/coat.

- B. Concrete/Masonry, Opaque, Latex, 3 Coat (4 at LtWt):
 - 1. Filler/Primer 1st coat: SW Block Filler B42W46.
(At all light-weight aggregate CMU: Two coats Filler/Primer.)
 - 2. Egg-Shell: 2nd and 3rd coats; SW Harmony Low Odor Latex Eg-Shel B9. 1.6 mil DFT/coat.
- C. Ferrous Metals, Pre-primed, Acrylic, 2 Coat:
 - 1. Touch-up with compatible primer.
 - 2. Semi-gloss: 1st and 2nd coats; SW ProClassic Water-borne Acrylic B31. 1.4 mils DFT/coat.
- D. Galvanized Metals, Latex, 3 Coat:
 - 1. Primer 1st coat: SW Pro-Cryl Universal Primer B66-310. 2-4 mils DFT.
 - 2. Semi-gloss: 2nd and 3rd coats; SW ProClassic Waterborne Enamel B31. 1.4 mils DFT.
- E. Gypsum Board, Latex, 3 Coat:
 - 1. Applications:
 - a. Eggshell: For general walls.
 - b. Flat: For ceilings and soffits.
 - c. Semi-gloss: For toilet rooms, bathrooms and shower rooms.
 - 2. 1st coat primer; SW Harmony Interior Latex Primer, B11W00500, 1.3 mils DFT
 - 3. Semi-gloss: 2nd and 3rd coats; SW Harmony Low Odor Latex, B10-900 Series, 1.6 mils DFT/coat.
 - 4. Eggshell: 2nd and 3rd coats; SW Harmony Low Odor Latex, B09-500 Series, 1.6 mils DFT/coat.
 - 5. Flat: 2nd and 3rd coats; SW Harmony Low Odor Latex B05-500 Series, 1.8 mils DFT/coat.
- F. Fire-Retardant Coating, Intumescent, 2 Coat:
 - 1. 1st coat; International Paint Interchar 1120.
 - 2. 2nd One coat ; A/D Colorcoat manufactured by A/D Fire Protection Systems, Inc..
- G. Fabrics/Insulation Jackets, Water-based Enamel, 3 Coat:
 - 1. 1st coat primer sealer; SW PrepRite 200 Latex Primer B28W200.
 - 2. Semi-gloss: 2nd and 3rd coats; SW ProClassic Waterborne Enamel B31. 1.4 mil DFT
- H. Concrete/Masonry: Glass flake reinforced epoxy resin. 3 Coats:
 - 1. Application(s): Diesel/oil containment area (Fire Pump).
 - 2. Coating: Two top coats and one coat primer.
 - 3. Product(s):
 - a. Tough and Easy Containment Sealer by Rust-oleum
 - b. Containment Area Sealer by WATCO Industrial Flooring
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 4. Primer: As recommended by manufacturer of top coats.
- I. Concrete: Acrylic-Epoxy. 3 Coats:
 - 1. Application(s): Garage Level parking and where indicated.
 - 2. Coating: Two top coats and one coat primer.
 - 3. Top Coat Product(s):
 - a. Epoxy-Seal Pro by Seal-Krete
 - 4. Primer(s): As recommended by manufacturer of top coats.
 - 5. Additives: Clear-Grip by Seal-Krete
- J. Pavement Marking Paint:(Interior Garage Level). 1 Coat:
 - 1. Yellow: One coat, with reflective particles; Sher-Lane by Sherwin Williams.
 - a. Applications: Safety areas as designated within Garage Level.
 - 2. White: One coat, with reflective particles; Sher-lane by Sherwin-Williams.
 - a. Applications: General striping within Garage Level.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Other materials not specifically indicated but required to achieve the finishes specified; commercial quality, "best grade" of "first line" made by reputable, recognized manufacturers, shall be compatible with related products and shall bear manufacturer's labels.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 WORKMANSHIP

- A. Employ skilled mechanics to ensure the very best workmanship. Quality workmanship is required. Materials shall be applied by craftsmen experienced in the use of the specific product involved.
- B. All materials shall be applied in strict accordance with the manufacturer's printed instructions.
- C. Finish work shall be uniform and of the approved color. Paint and stain shall completely cover, be smooth and free from runs, sags, clogging, excessive flooding, or brush marks. Make edges of paint and stain adjoining other materials or colors sharp and clean without overlapping.

3.02 EXAMINATION

- A. Do not begin application of coatings until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 4. Concrete Floors and Traffic Surfaces: 8 percent.
- F. Submit test results and action taken to the Architect prior to the application of paint products.
- G. Prime coats specified herein will not be required on items delivered with shop or factory prime coats already applied, providing that shop prime coats are equal in quality to those specified and the painting subcontractor determines their total compatibility with finish coats.

3.03 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to coating application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. General: Do not begin painting on any surface until it is in proper condition to receive the paint or as specified. Should any surface be found unsuitable to produce a proper finish, the Architect and product manufacturer shall be notified in writing and no material shall be applied until the unsuitable surfaces have been made satisfactory.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Seal surfaces that might cause bleed through or staining of topcoat.
- F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- G. New Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium

phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry. Fill all minor irregularities with approved patching materials and rub to a texture similar to adjacent surfaces. New concrete and masonry shall not be coated for at least 30 days.

1. Testing: Determine alkalinity and moisture content of surfaces by performing appropriate tests. Submit results to the Architect. If the alkalinity of the surfaces could cause the paint to blister and burn, correct this condition before application. Do no paint surfaces where moisture content exceeds that permitted by the paint manufacturer.
- H. New Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound and sand to smooth level surface. Exercise care to avoid raising nap of paper. Spot prime defects after repair.
- I. For Previously Painted Gypsum Board Surfaces: Remove grease, dirt, and other foreign materials as necessary to receive paint. Lightly sandpaper to smooth and even surface and then dust off. Fill all minor irregularities with approved patching materials and sand to smooth level surface. Exercise care to avoid raising nap of paper. Prime paint any patched surfaces.
- J. Insulated Coverings to be Painted: Remove dirt, grease, and oil from canvas, plastic and cotton.
- K. Concrete Floors to be Painted: Remove contamination, acid etch or shot-blast to a profile of 80-100 grit sandpaper, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry. A sample area shall be prepared for approval. New concrete shall not be coated for at least 30 days.
- L. New Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer or abrade all surfaces with 60 grit paper to create a uniform anchor profile, then prime.
- M. Corroded Steel and Iron Surfaces to be Painted: Prepare using at least SSPC-SP 2 (hand tool cleaning) or SSPC-SP 3 (power tool cleaning) followed by SSPC-SP 1 (solvent cleaning).
- N. New Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.
- O. New Shop-Primed Interior Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- P. Previously Painted Ferrous Metal: Remove grease, dirt, rust, and other foreign materials as necessary to receive paint. Sandpaper surfaces to a smooth, even surface and dust off. Touch-up any chipped or abraded surfaces and fill all holes and other surface imperfections with metal repair bondo, sand smooth and prime.
- Q. New Wood Items to Receive Opaque Finish: Sandpaper to smooth and even surface, then wipe off dust and grit prior to priming or staining. After priming or stain coat has been applied, thoroughly fill all nail holes and other surface imperfections with putty tinted with primer or stained to match wood color for interior locations and tinted exterior caulking for exterior locations. Seal knots, pitch streaks, and sappy sections with reduced shellac. Sand between coats. Back prime concealed surfaces before installation. Use gloss varnish reduced by 25 percent with thinner for transparent finishes.
- R. Non-compatible Shop Primers: Cover with suitable barrier coat or remove primer and reprime as required.
1. Testing: Apply a test patch of the new painting system to test for adhesion. Allow to dry one week before testing per ASTM D3359. If new painting system lifts, completely remove the existing finish.
- S. New Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with tinted primer.

3.04 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Spray painted wall surfaces shall be back-rolled.
- C. No interior painting or finishing shall be permitted until the building has been thoroughly dried out. See Environmental Requirements for application air temperature requirements. Relative humidity shall be 75% maximum. Moisture levels for painting shall be within 5 degrees F of the dew point and shall be determined by use of an electronic moisture meter.
- D. The atmosphere shall be relatively free of airborne dust. Each coat of paint shall be applied smoothly, worked out evenly and allowed to dry completely before the subsequent coat is applied. Follow manufacturer's labeled instructions for drying time between coats
- E. Apply products in accordance with manufacturer's instructions.
- F. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- G. Before painting, remove hardware, accessories, plates, lighting fixtures and similar items or provide ample protection of such items. On completion of each area, replace items removed.
- H. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- I. Sand wood and metal surfaces, enamels and varnishes lightly between coats to achieve required finish.
- J. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- K. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- L. All closets shall be finished the same as adjoining rooms, unless otherwise indicated.
- M. All doors and frames shall have the same finish and number of coats on both interior and exterior sides. Do not paint over door and frame fire-rating labels.
- N. All exposed structures (columns, trusses, beams, joist, deck, etc.) shall be painted the same color selected by the Architect, unless specifically indicated otherwise.
- O. All exposed steel stair components shall be painted, unless otherwise indicated, including but not limited to stringers, stair and landing pans, support structure, and railings.
- P. Upon completion, touch up and restore finish where damaged and leave in good condition.
- Q. Paint shop-primed equipment.
- R. Access panels, registers, cabinet heaters, radiators, and electrical panels and similar equipment shall be painted in colors as selected by the Architect.
- S. Exposed piping, conduit, wiremold, ductwork, pipe insulation, and hangers shall be painted in colors selected by the Architect.
- T. Access panel doors and frames shall be painted to match wall color.
- U. Upon completion of painting, reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 INSTALLATION OF FIREPROOFING COATING

- A. Fireproofing coating shall be provided at the following locations:
 - 1. All steel lintels greater than six (6) feet in length that support load bearing masonry walls.
- B. Clean and prepare steel as recommended by the coating manufacturer. Provide base coat if required for specific applications.
- C. Spray apply in strict accordance with the manufacturer's instructions and recommendations as required to provide a 2-hour fire rating as indicated on the Drawings.

- D. Finish coat shall match color sample approved by the Architect. Finish shall be smooth and uniform.

3.06 CLEANING AND PROTECTION

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.07 PROTECTION

- A. Protect finished coatings until completion of project.
- B. Touch-up damaged coatings after Substantial Completion.
- C. Provide drop cloths in all areas where painting is being done to protect floors and other work from damage during painting. Mask or otherwise protect smaller objects adjacent to painted surfaces.
- D. Waste materials shall not be disposed of in the existing sanitary system.
- E. When the Work of this Section is completed, remove all surplus materials and scaffolding from the premises and clean off all misplaced paint, varnish, stain and the like so as to leave the premises in perfect condition, free of all paint.

END OF SECTION

SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building identification signs.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- C. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
- D. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Dimensional Letter Signs:
 - 1. Gemini Signs: Cast Aluminum
 - 2. Impact Signs: Cast Aluminum
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SIGNAGE APPLICATIONS

- A. Building Identification Signs:
 - 1. Use individual metal letters.
 - 2. Mount on outside wall in location shown on drawings.

2.03 DIMENSIONAL LETTERS

- A. Metal Letters:
 - 1. Metal: Aluminum casting.
 - 2. Finish: Brushed, satin.
 - 3. Height: 15 inches.
 - 4. Mounting: Concealed screws.
 - a. Mounting: 1 inch, Projected.

2.04 ACCESSORIES

- A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Locate signs where indicated:

1. If no location is indicated obtain Owner's instructions.
- D. Protect from damage until Substantial Completion; repair or replace damage items.

END OF SECTION

SECTION 10 14 25
CODE REQUIRED BUILDING SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. All interior signage shall be provided by the Owner. This Section describes code required signage.
- B. Note: See Civil Drawings for code required exterior site signage.

1.02 REFERENCES

- A. ANSI/ICC A117.1 - Accessible and Useable Buildings and Facilities; 2009.
- B. IBC - International Building Code; 2009.
- C. ADAAG - Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.

PART 2 PRODUCTS

2.01 INTERIOR SIGNS

- A. Accessibility-Compliant Interior Signage:
 - 1. General: Signs with tactile lettering, numbers and symbols raised 1/32 inch minimum from sign plate face.
 - 2. Lettering Style: Sans serif, standard medium, upper case.
 - 3. Character width, stroke width, character spacing and line spacing shall comply with ANSI A117.1 requirements.
 - 4. Braille: Grade 2 Braille, placed directly below the corresponding text, and for multi-line text below the entire text. Spacing and dimensions shall comply with ANSI A117.1 requirements.
 - 5. Performance: Non-static, fire-retardant, and self-extinguishing.
 - 6. Contrast: Non-glare finish; letters numbers and symbols shall contrast with background.
 - 7. Borders, Materials and Colors: As selected by the Owner.
 - 8. Letter and Number Sizes: 1 inch.
 - 9. Pictograms: International Symbol of Access shall have a field size of 6 inches x 6 inches minimum. Characters and Braille shall not be in the pictogram field. Other types, if provided, shall be located in a clear area 6 inches high.
 - 10. International symbol of accessibility shall meet layout standards in ANSI A117.1.
 - 11. Sign Sizes: As required by sign content and selected by the Owner, but in no case less than 7 by 7 inches.
- B. Required Sign Types:
 - 1. Toilet Rooms: All toilet rooms shall be identified by "Men", "Women", "Restroom" and as scheduled
 - a. Accessible toilet rooms shall receive a 6" x 6" International Symbol of Access, as specified for door signs.
 - b. Pictograms, if provided shall be located directly above the related text.
 - 2. Sprinkler Equipment Rooms: Room name sign.
 - 3. Exits: All doors with lighted exit signs shall be identified by "Exit" text signs. See Electrical Drawings for locations of lighted exit signs.
 - 4. Capacity Signs: All assembly spaces shall receive a room capacity sign with text "Capacity XXX Persons". Locate signs within the assembly space, near the main entrance..
 - a. Capacity signs shall be provided for the following spaces: Auditorium #132 and Roof Deck 5014.

5. Stairs: At new stairs serving 3 or more stories and at existing stairs serving 5 or more stories, provide the following signs located within stair enclosures at all floor landings. Signs shall be visible when doors are open. Sign text shall include the following:
 - a. Floor level designation.
 - b. Level of top and bottom terminus of the stair enclosure.
 - c. Stair identifying name.
 - d. Floor level of and direction to exit discharge.
6. Elevators (not part of an accessible means of egress): Provide a sign indicating the location of the accessible means of egress. Elevators that are part of an accessible means of egress shall have signage provided as part of the scope of Section 14 20 10 - Passenger Elevators.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify mounting heights and locations for interior signage will comply with referenced standards.
- B. Clean mounting locations of dirt, dust, grease or similar conditions that would prevent proper installation.

3.02 INSTALLATION

- A. Install signs level, plumb, without distortion, and in proper relationship with adjacent surfaces using manufacturer's recommended standard mounting system.
- B. Sign mounting locations shall be in compliance with referenced codes.
 1. In general, signs shall be mounted no higher than 60" above the floor to the baseline of the highest line of text and no lower than 48" above the floor to the baseline of the lowest line of text Braille. Sign mounting height shall be consistent throughout the Project and reviewed with the Owner and Architect prior to installation.
 2. Door signs shall be mounted within 18" of door latch jambs. Signs shall not be located so as to be obscured by doors in the open position.
 3. At double doors with one inactive leaf, the sign shall be mounted on the inactive leaf.
 4. At double doors with two active leaves, the sign shall be located to the right of the right hand door.
 5. Where there is no wall space on the latch side of a single door, or to the right of double doors, signs shall be located on the nearest adjacent wall.
 6. Tactile signs shall be located to provide a clear floor area 18 inches by 18 inches minimum, centered on the tactile sign beyond the arc of any door swing between the closed position and 45 degree open position.

END OF SECTION

SECTION 10 21 13.19
PLASTIC TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Phenolic toilet compartments.
- B. Urinal and vestibule screens.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Concealed wood blocking.
- B. Section 10 28 00 - Toilet, Bath, and Laundry Accessories: Accessories mounted on compartments.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- C. Product Data: Provide data on panel construction, hardware, interior finish classification certification and accessories.
- D. Samples: Submit one set of samples of partition panel material, 3 x 3 inch in size illustrating panel finish, color, and sheen.
- E. Manufacturer's Installation Instructions: Indicate special procedures.

1.05 QUALITY ASSURANCE

- A. Materials shall meet interior finish classification Class B as tested in accordance with NFPA 286 Standard Method of Test of Surface Burning Characteristics of Building Materials.

1.06 WARRANTY

- A. Submit a fifteen (15) year manufacturer's warranty covering all plastic components against breakage, corrosion, and delamination.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Phenolic Toilet Compartments:
 - 1. Phenolic Series 700 by Bradley.
 - 2. Substitutions: Section 01 60 00 - Product Requirements.

2.02 PHENOLIC TOILET COMPARTMENTS

- A. Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid phenolic core panels with integral melamine finish, floor-mounted unbraced.
- B. Screens: Without doors; to match compartments; mounted to wall with two panel brackets with vertical support/bracing same as compartments.
- C. Toilet Compartments: Solid molded phenolic plastic panels, doors, and pilasters, floor-mounted unbraced.
 - 1. Surface Finish: Smooth and uniform; no saw marks.
 - 2. Recycled Content: Minimum 50%.
 - 3. Colors: As selected from manufacturer's full range.

- D. Door and Panel Dimensions:
 - 1. Thickness: 1 inch.
 - 2. Door Width: 24 inch.
 - 3. Door Width for Accessible Compartments: 36 inch, out-swinging.
 - 4. Toilet Height: 55 inch. 14 inches above floor, 13 inches to overhead rail.
 - 5. Thickness of Pilasters: 1 inch.
 - 6. Pilaster Height: 82 inches.
 - 7. Urinal Screen Height: 42 inch. 14 inches above floor.
 - 8. Privacy Screen Height: 55 inch. 14 inches above floor.
- E. Urinal Screens: Wall mounted with two panel brackets or a continuous U bracket, and for screens wider than 18 inches, provide floor-to-ceiling vertical upright consisting of pilaster anchored to floor and ceiling. Construction shall be the same construction and finish as indicated for partitions.

2.03 ACCESSORIES

- A. Pilaster Shoes: Formed ASTM A 666, Type 304 stainless steel with No. 4 finish, 3 in high, concealing floor fastenings.
 - 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster. Shoes shall be anchored to floor with stainless steel fasteners.
- B. Head Rails: Hollow stainless steel tube, 1 x 1-5/8 inch size, with anti-grip strips and stainless steel socket wall brackets.
- C. Pilaster Brackets: Natural anodized aluminum.
- D. Wall Brackets: Continuous U type, aluminum.
- E. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
 - 1. For attaching panels and pilasters to brackets: Through-bolts and nuts; tamper proof.
- F. Hardware:
 - 1. Hinges: Adjustable for door close positioning; two per door. Out-swinging doors shall be adjusted to return to the fully closed position, in-swinging doors shall be adjusted to return to the partially open position.
 - a. Nylon bearings.
 - 2. Door Latch: Zamak, Slide type with exterior emergency access feature.
 - 3. Door Strike and Keeper: Zamak with rubber bumper; mounted on pilaster in alignment with door latch.
 - 4. Coat Hook: Zamak with rubber bumper; one per compartment, mounted on door.
 - 5. Door Pull: Zamak, two (inside and outside) for outswinging doors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify correct spacing of and between plumbing fixtures.
- C. Verify correct location of built-in framing, anchorage, and bracing. Start of Work constitutes acceptance of job conditions.

3.02 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions. Conceal evidence of drilling in floors and walls in finish work.
- B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters. Maintain 1/4 inch between pilasters and doors.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.03 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING AND CLEANING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.
- D. After completion of installation, clean and polish exposed compartment and screen surfaces. Remove all protective masking and clean surfaces, leaving them free of soil and imperfections.

END OF SECTION

SECTION 10 26 01
WALL AND CORNER PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Bumper rails.
- B. Wall protection panels.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Support blocking for wall anchors.
- B. Section 09 21 16 - Gypsum Board Assemblies: Metal stud wall construction.

1.03 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; 2009.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- D. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2012.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.
- C. Shop Drawings: Submit seaming diagrams for all wall protection panels.

PART 2 PRODUCTS

2.01 COMPONENTS

- A. Bumper Rail: Factory fabricated, extruded EPDM Rubber.
 - 1. Application(s): Garage Level - parking.
 - 2. Color: Black.
 - 3. Size: 1 1/2 inch x 8 inch.
 - 4. Length(s): See Drawings.
 - 5. Product(s): Series E-1 Extruded Bumper by Pawlings Corporation
 - 6. Substitutions: See Section 01 60 00 - Product Requirements
- B. Wall Protection Panels (Item 50B): 0.060" thickness, rigid PVC; manufacturer's accessories.
 - 1. Fire-rating: UL723 Class A; Flame Spread 20 or less; Smoke Developed 400 or less.
 - 2. Top Edge: Top cap trim.
 - 3. Seams: Matching sealant for butt joints.
 - 4. Panel Height: As indicated on the Drawings.
 - 5. Panel Size: Maximum sheet size to minimize seams, and panel layout as identified on interior elevation Drawings, as applicable.
 - 6. Colors / Texture: As selected by the Architect from the manufacturer's full range. Panels shall be color matched.
 - 7. Adhesive: Water-based, low odor, as recommended by the panel manufacturer.
 - 8. Product: PVC Wallcovering by InPro Corp.
 - 9. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Wall Protection Panels (Type VW-1): 0.40" thickness, PVC alloy composite; manufacturer's accessories.
 - 1. Fire-rating: UL723 Class A; Flame Spread 25 or less; Smoke Developed 400 or less.

2. Seams: Matching sealant for butt joints
 3. Top Edge: As detailed on the Drawings.
 4. Panel Height: See interior elevations on the Drawings.
 5. Colors: See Finish Legend. or As selected by the Architect from the manufacturer's full range.
 6. Adhesive: Water-based, low odor, as recommended by the panel manufacturer.
 7. Product: Ven4ma Sheet Wall Protection by Spectrim Building Products.
 8. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Wall Protection Panels Type VWC-1: 100% spun woven glass fabric wall covering.
1. Fire-rating: UL723 Class A; Flame Spread 25 or less; Smoke Developed 400 or less.
 2. Gauge: 34 mils.
 3. Total Weight: 27.0 oz PLY
 4. Nominal Pattern Width: 51 inches.
 5. Fabric Backing: Osnaburg.
 6. Color / Texture: Crystobal
 7. Product: Vicrtex Buglebeads by Koroseal
 8. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.
- F. Primers and Adhesives: As recommended by manufacturer.

2.02 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on Drawings.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, at proper height.
- B. Wall Protection Panels:
 1. Verify wall surfaces are primed.
 2. Clean substrate surfaces to remove dust, debris and loose particles.
 3. Locate panel seams per approved shop drawings.
 4. Adhere panels to substrate with troweled on adhesive as recommended by the panel manufacturer. Smooth roll the surface.
 5. Clean-up surfaces in accordance with manufacturers maintenance instructions.
- C. Position centerline of garage bumper rail 18 inches from finished floor.

3.03 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch.
- B. Maximum Variation From Level or Plane For Visible Length: 1/8 inch.

END OF SECTION

SECTION 10 28 00
TOILET ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Accessories for toilet rooms, residential bathrooms, and utility rooms.
- B. Accessories for sinks and other fixtures at locations indicated on the Drawings.
- C. Grab bars.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Concealed wood blocking.
- B. Section 09 21 16 - Gypsum Board Assemblies: Metal stud partitions for special loading imposed by grab bars, diaper changing stations, etc.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities; current edition.
- B. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
- D. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium; 2011e1.
- E. ASTM C1036 - Standard Specification for Flat Glass; 2011e1.
- F. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2008 (Reapproved 2013).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement to receive anchor attachments.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.
- C. Samples: Submit one sample of each accessory, illustrating color and finish, if requested by Architect.
- D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.
- E. Close-out Requirements: Submit maintenance data, operating instructions and keys required for each type of equipment and lock.

1.06 PRODUCT HANDLING

- A. Deliver items in manufacturer's original unopened protective packaging. Store materials as required to prevent soiling, damage, or wetting. Maintain protective covers on all units. Remove protective covers at final clean-up of installation.

1.07 WARRANTY

- A. Provide manufacturer's standard product warranty for mirrors against silver spoilage for ten (10) years.
- B. Provide manufacturer's standard product warranty for hand and hair dryers against defects in materials and workmanship for ten (10) years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Bobrick Washroom Equipment, Inc..
- B. Other Acceptable Manufacturers:
 - 1. Bradley Corp.
 - 2. McKinney Parker.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.
- C. All items of each type to be made by the same manufacturer.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- B. Stainless Steel Sheet: ASTM A 666, Type 304, 0.034 inch (22 gage) minimum thickness, unless otherwise indicated.
- C. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653, with G90/Z275 coating.
- D. Mirror Glass: See Section 08 80 00.
- E. Adhesive: Two component epoxy type, waterproof.
- F. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof and of same materials as accessory where exposed.

2.03 FINISHES

- A. Stainless Steel: No. 4 Brushed finish, unless otherwise noted.
- B. Chrome/Nickel Plating: ASTM B456, SC 2, satin finish, unless otherwise noted.
- C. Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.
- D. Back paint components where contact is made with building finishes to prevent electrolysis.

2.04 TOILET ROOM ACCESSORIES

- A. NOTE: Accessory item numbers correspond to accessory symbol numbers on the Drawings.
- B. Item 1C - Toilet Paper Dispenser: Single roll, surface-mounted, brushed nickel, with integral grab bar.
 - 1. Products:
 - a. # 61028 by Live Well.
- C. Item 3A - Combination Towel Dispenser/Waste Receptacle: Recessed (4" deep wall space) flush with wall, stainless steel; seamless wall flanges, continuous piano hinges, tumbler locks on upper and lower doors.
 - 1. Product: B-4369 by Bobrick.
- D. Item 6A - Feminine Napkin Dispenser: Stainless steel, surface-mounted, or semi-recessed.
 - 1. Door: Seamless 0.05 inch door with returned edges and tumbler lock.
 - 2. Cabinet: Fully welded, 0.03 inch thick sheet.
 - 3. Operation: 25 cent coin required to operate dispenser. Provide locked coin box, separately keyed.
 - 4. Identify dispensers slots without using brand names.
 - 5. Minimum capacity: 15 napkins and 20 tampons.
 - 6. Products:
 - a. B-435009 by Bobrick.

- E. Item 7A and 7B - Mirror: Wood frame, tempered glass mirror; non-absorptive backing filler and galvanized sheet steel backer plate; surface mounted.
 - 1. Item 7A Size: Rectangular shapes with wood frames in the following sizes (glass area): 36 x 36, 48 x 36, 56 x 32, 25 x 34, 34 x 34 in locations and quantities as indicated per the Drawings.
 - 2. Item 7B Size: Oval frameless, 36 x 24 in locations and quantities as indicated per the Drawings.
 - 3. Products:
 - a. Frame custom: See 06 20 00 - Finish Carpentry.
 - b. Glazing mirror: See 08 80 00 - Glazing.
- F. Item 9A - Medicine Cabinet: Stainless steel cabinet, shelves, door, hinge, framed float glass mirror with wood frame, surface mounted, 5" D x 18" W x 36" H.
 - 1. Shelves: Adjustable, glass; provide not less than 3 shelves.
 - 2. Door: Fitted with continuous piano-type hinge, magnetized catch, swing to be confirmed in shop drawings.
 - 3. Products:
 - a. To Be Determined
- G. Item 10C - Soap Dispenser: Surface mounted.
 - 1. Product: Furnished by Owner, installed by Contractor.
- H. Item 11A - Robe Hook: Heavy-duty stainless steel, single-prong, brushed nickel finish.
 - 1. Products:
 - a. Model # YB2403BN by Moen
- I. Item 12A - Towel Bar: Brushed nickel, 1 1/4 inch round, surface mounted.
 - 1. Minimum rated point load: 250 pound-force.
 - 2. Products:
 - a. Model # 24200 by Live Well
- J. Item 13B - Grab Bars; Brushed nickel, surface mounted.
 - 1. Standard Duty Grab Bars:
 - a. Minimum rated point load: 250 pound-force.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, concealed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Grab bars at shower units: Provided by shower manufacturer per Division 22.
 - d. Products:
 - 1) Model # 36200 by Live Well
 - 2) Model # 42200 by Live Well
 - 3) Model # 81200 WOM by Live Well
- K. Item 19 - Shower Seat:
 - 1. Product: Furnished by Owner, placed by Owner.
- L. Item 21 - Shower Curtain Rod: See Division 22, included as scope within the specified shower enclosure.
- M. Item 21A - Shower Curtain and Hooks:
 - 1. Material: Opaque vinyl, 0.008 inch thick, matte finish, with antibacterial treatment, flameproof and stain-resistant.
 - 2. Size: 42 x 72 inches, or height and length as required; hemmed edges.
 - 3. Grommets: Stainless steel; pierced through top hem on 6 inch centers.
 - 4. Color: White.
 - 5. Shower curtain hooks: Chrome-plated or stainless steel spring wire designed for snap closure.
 - 6. Products:
 - a. Typical Shower Units: B-204 by Bobrick.
 - b. ADA Shower Units: ADA Shower Curtain by Inpro

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work. Check opening scheduled to receive recessed units for correct dimensions, plumbness of blocking or frames, and preparation that would affect installation of accessories.
- B. Verify exact location of accessories for installation. Check for conditions that would affect placement, quality and execution of work.
- C. Verify that field measurements are as indicated on drawings. Verify spacing of plumbing fixtures and toilet partitions that affect installation of accessories.
- D. See Section 06 10 54 - Wood Blocking and Curbing, for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings. Do not begin installation of accessories until openings and surfaces are acceptable and adequate blocking has been provided

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on the drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights and Locations: As required by accessibility regulations and as indicated on drawings.
- D. Secure all items to concealed blocking or anchor plates installed in walls. All anchors shall be fully concealed.
 - 1. Stationary grab bar mounting devices and supports within walls shall support a concentrated force of 250 pounds applied at any point in any direction 4" from the face of the wall.
- E. Install shower curtains and rods to allow bottom of curtain to hang between 1" and 3" above floor or shower base. ADA shower units hang per manufacturer instructions to create a water dam at base of shower.
- F. Adjust accessories for proper operation. After completion of installation, clean and polish all exposed surfaces. Deliver keys and instruction sheet to Owner. All keys shall be clearly labeled.
- G. Paper towel and soap dispensers shall be installed at all sinks outside of restrooms, whether indicated or not on the Drawings.

END OF SECTION

SECTION 10 31 00
MANUFACTURED FIREPLACES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufacturer electric fireplaces.
- B. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 00 - Gypsum Board Assemblies: Framing rough opening and enclosures.
- B. Division 26 - Electrical. Equipment wiring.

1.03 REFERENCE STANDARDS

- A. UL - 2021
- B. CSA - C22.2 No.46

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide fire box cabinet dimensions, clearances required from adjacent dissimilar construction, applicable regulatory agency approvals, electrical characteristics of fan.
- C. Manufacturer's Certificate: Certify that fireplace components meet or exceed UL requirements.
- D. Manufacturer's Instructions: Indicate installation procedures and component installation sequence, clearances and tolerances from adjacent construction.

1.05 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and labeled by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

1.07 WARRANTY

- A. Standard manufacturer's two (2) year limited warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufactured Fireplaces:
 - 1. Basis of Design:
 - a. Unit Type 1: Synergy BLF-50 by Dimplex North America.
 - b. Unit Type 2: Galveston BLF-74 by Dimplex North America.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

- A. General:
 - 1. Provide all components and accessories required for a complete, functional unit.
 - 2. UL or CSA listed.
- B. Unit Type 1: Pre-fabricated Electric Fireplace: Realistic 50" wall mounted electric fireplace.
 - 1. Unit Dimensions:
 - a. Width: 50-1/4 inches

- b. Height: 19-1/2 inches
 - c. Depth: 7 inches
 2. Framing Type: Fully recessed.
 3. Electrical:
 - a. Volts: 120
 - b. Watts: 1,230
 - c. BTUs: 4,197
 - d. Amps: 10.3
 4. Venting: Non-venting.
 5. Operation: Flame and heat.
 6. Heating: Louver-less, fan-forced circulation.
 7. Liner: Steel.
 8. Standard Features:
 - a. Flame/ember bed on/off.
 - b. Tumbled glass media ember bed.
 - c. LED flame technology.
 - d. On-demand fan-forced heater.
 - e. Direct wire capabilities - 120V.
 9. Optional Trim Kit: Cohesion surround in black.
 10. Controls:
 - a. Wall switch remote control kit.
- C. Unit Type 2: Pre-fabricated Electric Fireplace: Realistic 74" wall mounted electric fireplace.
 1. Unit Dimensions:
 - a. Width: 74-1/4 inches
 - b. Height: 19-1/2 inches
 - c. Depth: 7 1/2 inches
 2. Framing Type: Fully recessed.
 3. Electrical:
 - a. Volts: 120
 - b. Watts: 1,230
 - c. BTUs: 4,197
 - d. Amps: 10.3
 4. Venting: Non-venting.
 5. Operation: Flame and heat.
 6. Heating: Louver-less, fan-forced circulation.
 7. Liner: Steel.
 8. Standard Features:
 - a. Flame/ember bed on/off.
 - b. Tumbled glass media ember bed.
 - c. LED flame technology.
 - d. On-demand fan-forced heater.
 - e. Direct wire capabilities - 120V.
 9. Optional Trim Kit: Cohesion surround in black.
 10. Controls:
 - a. Wall switch remote control kit.

2.03 ACCESSORIES

- A. Fasteners and Anchors: Galvanized steel type.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Verify that prepared openings are ready to receive work and opening dimensions are as indicated on drawings.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install unit assembly in accordance with manufacturer's instructions and UL requirements.
- B. Use manufacturer's guidelines for minimum clearances to combustibles, walls and finishes.
- C. Anchor all units firmly.

END OF SECTION

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.
- D. See Code Analysis Key Plan Drawings for fire extinguisher locations.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Wood blocking and shims.
- B. Section 09 21 16 - Gypsum Board Assemblies: Roughed-in metal stud wall openings.
- C. Division 26 - Electrical: Fire alarm monitoring.

1.03 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers; 2013.
- B. UL - Fire Protection Equipment Directory; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate cabinet physical dimensions and rough-in measurements for recessed cabinets. Verify that cabinets are sized to accommodate the type and capacity of extinguishers specified.
- C. Product Data:
 - 1. Submit fire extinguisher cabinet and extinguisher operational features, color and finish, and anchorage details.
- D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.05 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer (Basis of Design): J.L. Industries.
- B. Acceptable Manufacturers:
 - 1. Larsen's Manufacturing Co
 - 2. Pyro-Chem
 - 3. Amerex Corp.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL for the purpose specified and indicated.

- B. Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gage.
 - 1. Class: 2A:10BC.
 - 2. Size: 10 pound.
 - 3. Location: General use.
 - 4. Finish: Baked polyester powder coat, red color.
- C. Wet Chemical Type: Stainless steel tank, with pressure gage.
 - 1. Class 2A:1B:1C:K.
 - 2. Size: 2.5 gallon
 - 3. Location: Kitchen.

2.03 FIRE EXTINGUISHER CABINETS

- A. General: Cabinets for fire-rated locations shall be listed and labeled to comply with requirements of ASTM E814 for the fire-resistance rating of the walls where they are to be installed.
- B. Item 60 - Product: JL Industries Clear-Vu Series # 1515 Fire-FX
- C. Item 63 - Product: JL Industries Clear-Vu Series # 1515.
- D. Metal: Formed primed steel sheet; 0.036 inch thick base metal.
- E. Cabinet Configuration: Recessed type.
 - 1. Sized to accommodate accessories.
 - 2. Trim: Flat, 1-3/4 inch wide face.
 - 3. Form cabinet enclosure with right angle inside corners and seams. Form perimeter trim and door stiles.
- F. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with continuous piano hinge. Provide nylon catch.
- G. Door Glazing: Plastic, clear, 1/8 inch thick acrylic. Set in resilient channel gasket glazing.
- H. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.
- I. Weld, fill, and grind components smooth.
- J. Finish of Cabinet Exterior Trim and Door: Baked enamel, color as selected.
- K. Finish of Cabinet Interior: White enamel.
- L. Provide ADAC option for cabinets located in fire-rated wall construction.

2.04 ACCESSORIES

- A. Item 64 - Extinguisher Brackets: Formed steel, chrome-plated. Provide wall brackets for all extinguishers not indicated to be in a cabinet. Brackets shall be as recommended by the fire extinguisher manufacturer for weight and size of the extinguisher to be hung. Finish shall match the extinguishers. Provide spring-type metal straps to secure the extinguisher on hook.
- B. Extinguisher Theft Alarm: Battery operated alarm, 10 second delay for disarming, activated by opening cabinet door.
- C. Cabinet Signage: # 24S by JL Industries Inc.
 - 1. Size: 5 inch by 6 inch.
 - 2. Type: 3D tent, plastic.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located. Verify fire extinguisher monitoring device wiring is in place for installation of the device adjacent to the extinguisher, within the cabinet for cabinet mounted extinguishers.

3.02 INSTALLATION

- A. Refer to the Drawings for locations of fire extinguisher cabinets and fire extinguishers (designated F.E.C.), wall mounted fire extinguishers without cabinets (designated F.E.). Locations shown on the Drawings are approximate. Verify all locations and mounting heights with the Architect prior to roughing-in of cabinets or mounting brackets. In general, fire extinguishers shall be installed no higher than 4'-6" AFF to top of unit.
- B. Install in accordance with manufacturer's instructions.
- C. Install cabinets plumb and level in wall openings, no higher than 4'-6" inches from finished floor to top of cabinet.
- D. Secure rigidly in place.
- E. Place extinguishers in cabinets and on wall brackets as indicated.
- F. All fire extinguishers shall be fully charged and inspected within one (1) month prior to date of Substantial Completion.

END OF SECTION

SECTION 10 55 00
POSTAL SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Central mail delivery boxes.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Fabricated metal pedestal and anchor bolts for mail box.
- B. Section 06 10 54 - Wood Blocking and Curbing.
- C. Section 06 20 00 - Finish Carpentry: Surrounding millwork and trim.
- D. Section 09 21 16 - Gypsum Board Assemblies.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. 39 CFR 111 - U.S. Postal Service Standard 4C; effective date September 3, 2006.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's specifications and descriptive literature, installation instructions, maintenance information, and current USPS approval documentation.
- C. Shop Drawings: Indicate plans for each unit or groups of units, front elevations with compartment layout and model number, overall dimensions, rough-in opening sizes, construction and anchorage details.

1.05 WARRANTY

- A. See Section 01 78 00 - Project Close-out, for additional warranty requirements.
- B. Provide manufacturer's warranty against defects in materials or workmanship for a period of 5 years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 CENTRAL MAIL DELIVERY BOXES

- A. Central Mail Delivery Boxes: Provide products approved for United States Postal Service (USPS) delivery.
 - 1. Materials: Aluminum with stainless steel hardware.
 - 2. Finish: Powder coat in color selected by Architect from manufacturer's standard colors.
 - 3. Unit Types and Sizes: As indicated on drawings.
 - 4. Configurations: See drawings for overall dimensions and layouts.
- B. Wall-Mounted Mailboxes: Fully-recessed, complying with USPS-STD-4C.
 - 1. Front-loading with pair of master doors, double-column design, 20 customer compartments, 1 outgoing mail compartment, and 2 parcel compartments.
 - a. National Mailboxes: Model H4C16D-20
 - b. Salisbury Industries; Model 4C Horizontal Mailbox.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

- A. Locking - Front Loading Master Door: Three-point latching mechanism with USPS master lock furnished and installed by postmaster.
- B. Locking - Customer Compartment Doors: USPS approved cam lock, 3 keys each lock.

- C. Locking - Parcel Compartment Doors: Double-lock arrangement with USPS approved cam lock for customer access, and USPS master lock furnished and installed by postmaster.
- D. Identification - Customer and Parcel Compartments: Sequential numerical or alphabetic characters, top to bottom, left to right; field-installed.
 - 1. Engraved characters, 3/4 inch high, with black fill.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough-openings are ready to receive wall-mounted units.
- B. Do not begin installation until unacceptable conditions are corrected.

3.02 INSTALLATION

- A. Install postal specialties in accordance with approved shop drawings, manufacturer's instructions, and USPS requirements.
- B. Adjust and lubricate door hardware to operate properly.
- C. Install mailbox identification items.

END OF SECTION

SECTION 11 31 00
RESIDENTIAL APPLIANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Kitchen appliances.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - Gypsum Board Assemblies
- B. Section 26 27 17 - Equipment Wiring: Electrical connections for appliances.
- C. Division 22 - Plumbing.
- D. Division 26 - Electrical.

1.03 REFERENCE STANDARDS

- A. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.
- B. UL 300A

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.
- C. Schedule: Submit a schedule of all appliances, using the same room designations indicated on the Drawings.
- D. Copies of Warranties: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section, with not less than three years of documented experience.
- B. Installer Qualifications: Shall be an experienced installer who is an authorized representative of the manufacturers for both installation and maintenance of appliances required for this Project.
- C. Electric Appliances: Listed and labeled by UL or Intertek (ETL) and complying with NEMA standards.
- D. Energy Ratings: Provide residential appliances that carry labels indicating energy-cost analysis (estimated annual operating cost) and efficiency information as required by the Federal Trade Commission.

1.06 WARRANTY

- A. See Section 01 78 10 - Warranties, for additional warranty requirements.
- B. Provide manufacturer's standard one (1) year product warranties agreeing to repair or replace residential appliances or components against failure in materials or workmanship within the specified periods. In addition, provide the following extended warranties:
- C. Provide five (5) year manufacturer warranty for in home service on refrigeration system of refrigerators.
- D. Provide ten (10) year manufacturer warranty for in home service on magnetron tube of microwave ovens.
- E. Provide ten (10) year manufacturer warranty for in home service on tub and door liner of dishwashers.

PART 2 PRODUCTS

2.01 KITCHEN APPLIANCES

- A. All Equipment Eligible for Energy Star Rating: Energy Star Rated.
- B. Manufacturer (Basis of Design): General Electric, unless indicated otherwise.
- C. Acceptable manufacturers:
 - 1. Maytag.
 - 2. White-Westinghouse.
 - 3. Frigidaire.
 - 4. Substitutes: See Section 01 60 00 - Product Requirements.
- D. Refrigerator: Free-standing, bottom-mounted freezer, frost-free.
 - 1. Capacity: Total minimum storage of 18 cubic ft; minimum 15 percent freezer capacity.
 - 2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by DOE.
 - 3. Features: Include glass shelves, automatic icemaker, and light in freezer compartment.
 - 4. Finish: Stainless steel.
 - 5. Manufacturers:
 - a. Amana; Product ABB1921BR.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Cooktop: Electric, with glass-ceramic cooktop.
 - 1. Size: 30 inches.
 - 2. Elements: 4.
 - 3. Features: Include downdraft exhaust.
 - 4. Finish: Cermaic glass, frameless.
 - 5. Manufacturers:
 - a. GE Appliances; Product GE Profile Series 30" Downdraft Electric Cooktop
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Wall Oven: Electric, single oven.
 - 1. Size: 30 inches.
 - 2. Oven: Self-cleaning with electronic ignition.
 - 3. Controls: Solid state electronic.
 - 4. Features: Include oven door window, broiler pan and grid, and oven light.
 - 5. Finish: Porcelain enameled steel, color as indicated.
 - 6. Manufacturers:
 - a. GE Appliances; Product Model # JTP30DPWW:
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Microwave: Over-the-range.
 - 1. Capacity: 1.9 cubic ft.
 - 2. Power: 1100 watts.
 - 3. Features: Include turntable and 2-speed exhaust fan.
 - 4. Finish: White.
 - 5. Manufacturers:
 - a. GE Appliances; Product Model # JVM7195DF:
- H. Dishwasher: Undercounter.
 - 1. Controls: Solid state electronic.
 - 2. Wash Levels: 3.
 - 3. Cycles: 4, including normal.
 - 4. Features: Include rinse aid dispenser, optional no-heat dry, optional water temperature boost, adjustable upper rack, and adjustable lower rack.
 - 5. Finish: Stainless steel.
 - 6. Manufacturers:

- a. Whirlpool Corp; Product Model # WDF518SAA:
- b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify utility rough-ins are present and correctly located.
- B. Examine cabinet installation with the appliance installer to verify proper conditions. Proceed with the installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Anchor built-in equipment in place to supporting cabinets or countertops with concealed fasteners.
- C. Verify that clearances are adequate for proper functioning and rough openings are completely concealed. Place freestanding equipment in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- D. Provide all miscellaneous installation kits, pigtails, washer hose, and dryer vent connections required for complete and proper installations for all appliances (Contractor and Owner furnished).

3.03 ADJUSTING

- A. Adjust operating equipment to efficient operation.

3.04 CLEANING

- A. Remove packing materials from equipment.
- B. Clean equipment, leave in a condition ready for operation.

END OF SECTION

SECTION 11 40 00
FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Sections, apply to this Section.

1.02 SCOPE

- A. Attention is directed to the detailed Item Specifications, which provide for minimum acceptable products. Item Specifications paragraphs may indicate materials or components that exceed the manufacturer's standards and are required for this project.
- B. Cooperate and coordinate with others engaged on the project in order that work will progress on schedule.
- C. Work to be performed under this Section is shown on Foodservice Equipment Drawings.
- D. Install materials furnished under this Section, other than materials that are expressly noted for installation under other Sections. Installation work shall be performed by workmen compatible with those existent on the project site. Equipment shall be of the latest design; new and unused, unless indicated otherwise in the Item Specifications, complete with all standard parts for normal operations and including such accessories or materials as may be required to comply with these Specifications.
- E. This Specification is to further describe and supplement the applicable Drawings. What is called for by either the Drawings and/or these Specifications shall be furnished and installed as part of this work. Any questions relative to discrepancies or omissions shall be submitted to the Architect.
- F. Provide neatly punched openings or cutouts required to permit passage of plumbing and electrical services by related trades and to accommodate mounted switches and receptacles in the equipment.
- G. Work in this Section shall include but shall not be limited to the following:
 - 1. Catalog items of equipment.
 - 2. Fabricated equipment other than catalog items.
 - 3. Plumbing trim consisting of mechanical system components required for standard operation of equipment items such as faucets and waste outlets. Vacuum breakers shall be furnished for equipment where water is introduced less than 2 in. above flood level.
 - 4. Electrical equipment forming an integral part of equipment items such as electric motors, heating elements, controls, switches, starters, temperature regulators and internal wiring to a control panel or switch, if mounted on the equipment.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Finished floor and walls, structural supports for all ceiling supported equipment, acoustical ceilings and related building.
- B. Connecting piping, waste lines, traps and vent piping, complete with shut-off valves to all the equipment, and the rough-in for sanitary waste, domestic water, floor drains and plumbing fixtures except those provided under this Section, and related mechanical work.
- C. Exhaust ventilating systems complete with blowers, ductwork, hangers, access panels, and insulation between the exhaust collars and the exhaust blowers.
- D. External wiring; the mounting and wiring of motor starters, solenoid valves, switches and receptacles not integral with the equipment; mounting and wiring of walk-in refrigerated room ceiling mount light fixtures; wiring of walk-in refrigerated room interior evaporator coils; connecting conduit, and external connections to equipment to the building electrical distribution system.

1.04 SUBMITTALS

- A. Submit Shop Drawings for approval in accordance with the General Conditions.
- B. Stub-in drawings shall indicate the layout of equipment and dimensioned locations of all services to the equipment.
 - 1. Hand drawn scale: 1/2 in. = 1 ft., 0 in.
 - 2. CAD drawn scale: 1/4 in. = 1 ft., 0 in.
 - 3. Stubbed services shall include electrical, hot and cold water, floor drains or floor sinks, solid wastes and exhaust collar connections. Point of connection services shall include steam supply, condensate return, gas connection and indirect waste connections. Service dimensions shall include height measured from finish floor.
 - 4. Electrical and plumbing services shall be indicated and coordinated on the same drawing.
 - 5. Call-outs for each stub point indicated at the point, or clearly keyed to a schedule on the same drawing.
 - 6. Special conditions plan shall include all floor recesses, curbs and special wall construction indicated and dimensioned
- C. Fabrication drawings shall be furnished for non-catalog items, showing plans, elevations and full construction details with gauges, components, fasteners, erection and connections. Drawings shall be to the minimum scale of 3/4 in. = 1 ft., 0 in.
- D. Standard items of equipment, not built-in or part of other assemblies shall be submitted for approval in the form of bound catalog cuts. Each cut shall include a clearly marked item number, a listing of all optional accessories and finishes, and connection data.
- F. Mechanical refrigeration system submittal shall include the firm name and address of the installation contractor and name of the qualified installer.

- G. Energy Star - Specified Energy Star rated equipment and appliances shall serve as the standard for all types of equipment and appliances whenever possible. Kitchen Equipment Contractor shall clearly indicate that items are Energy Star rated both on the submittal cover sheet and manufacturer cut sheets.
- H. Failure to comply with approved shop drawings shall be cause for rejection of an improperly built assembly.

1.05 SAMPLES

- A. If the bidder's proposed equipment fabricator is unknown to the Consultant's office, immediately after award of contract, submit the following samples for selection and approval:
 - 1. Section of table showing edge, bullnose, framing, fasteners, gusset, leg, and foot, all assembled.
 - 2. Drawer assembly (will be returned for use on this project).
- B. Work delivered to the job shall match approved samples.

1.06 GUARANTEES AND WARRANTIES

- A. New equipment furnished for this facility shall be guaranteed for a period of not less than one calendar year beginning on the date of final acceptance of the work of this Section. In the case of a manufacturer whose standard warranty exceeds this period the longer period shall apply. Self-contained refrigeration units for reach-in refrigerators, freezers, ice cream chests and ice machines shall carry a five-year replacement warranty for the sealed unit. The guarantee shall protect against defective material, design and workmanship.
- B. In addition to the guarantee called for under the General Conditions, this Contractor shall further agree that in the event of failure of any system or item of equipment or improper functioning of specified work during the guarantee period, he shall have "on call" competent service personnel available to make the necessary repairs or replacements of specified work promptly at no cost to the Owner. In the event that replacement of an entire item is required, the Owner shall have the option of full use of the defective equipment until a replacement has been delivered and completely installed.
- C. Furnish manufacturer's warranties for each item of standard equipment and a warranty on fabricated equipment. Submit guarantees and warranties to the Architect in accordance with conditions found in "Demonstration and Operating Instructions" paragraphs, contained in Part 3, this Section.

1.07 REGULATORY AGENCIES

- A. Work shall be in accordance with the governing health, building and safety, and fire protection codes and regulations.
- B. Standards of the National Sanitation Foundation (NSF) shall serve as guidelines for the work of this Section.
- C. Electric equipment and accessories shall conform to the standards of the National Electric Manufacturers Association (NEMA), Underwriters Laboratories, Inc. (UL) or Electrical Testing Station (ETS).
- D. Steam generating equipment and accessories shall conform to the standards of the American Society of Mechanical Engineers (ASME).
- E. Gas fired equipment and accessories shall conform to the standards of the American Gas Association (AGA) and the American National Standards Institute (ANSI) Z83.11.
- F. Energy Star - Specified Energy Star rated equipment and appliances shall serve as the standard for all types of equipment and appliances whenever possible.

1.08 EQUALITY OF MATERIALS AND EQUIPMENT

- A. The base bid shall contain no substitutions to these drawings or specifications. Bidders may offer substitute equipment in a separate proposal, indicating the proposed model and sum to be added or deducted if the alternate item is accepted by the Owner. Each line item shall include delivery, installation and taxes. Decisions to accept or reject a piece of equipment shall be made by the Owner, and all decisions shall be final.

PART 2 - PRODUCTS

2.01 MATERIALS AND FINISHES

- A. General
 - 1. Metals shall be free from defects impairing strength, durability or appearance, made of new materials with structural properties to withstand strains and stresses to which normally subject.
 - 2. Stock materials, patterns, products and methods of fabrication shall be approved provided that they conform to the requirements specified under Item Specifications.

B. Stainless Steel

1. Stainless steel shall be non-magnetic corrosion resistant chromium-nickel steel, Type 302 or 304 (18-8 Alloy), polished to a Number 4 finish where exposed, unless otherwise noted. Minimum gauges shall be as specified under Item Specifications.

C. Galvanized (Galvannealed) Steel

1. Galvannealed steel shall be commercial quality with tight coat of zinc galvanizing metal applied to a soft steel sheet, subsequently passed through a 1200 degree F. oven, resulting in a spangle free paintable surface. Minimum gauges shall be as specified under Item Specifications.

D. Plastic Laminate Materials

1. The laminate facing shall be GP-50, .050 in. thick, general purpose, high pressure, decorative plastic laminate that meets or exceeds the requirements of NEMA Publication LD3-1985, and NSF Standard 35. The plastic laminate exposed surfaces shall be provided in accordance with the specified manufacturer, finish and color. Balancing sheet shall be backing grade GP-28 in matching color at semi-exposed and BK-20 unfinished where hidden.
2. Plastic laminate covered surfaces shall be factory fabricated with 3/4 in. thick core having plastic laminate facing on both faces and all edges, laminated with waterproof glue under pressure in accordance with the plastic laminate manufacturer's specifications.
3. The core shall be medium density phenolic resin particleboard conforming to ANSI A208.1, Type 2-M-2, 45 pound per cubic foot density minimum.
4. Provide veneer core plywood or solid hardwood edge banding for doors and vertical dividers or panels where hardware is attached to casework.
5. Hinges shall be articulated, spring loaded type equal to Grass CST65-170-F or Stanley, with quantity adequate to support the door without deformation. Do not provide handles on plastic laminate clad doors.

2.02 CONSTRUCTION

A. General

1. Flat metal work items of equipment, such as tables, sinks, or counter tops, and other non-catalog items described under Item Specifications, shall be manufactured by a food service equipment fabricator who has the plant, personnel and engineering facilities to properly design, detail and manufacture high quality food service equipment.
2. The equipment fabricator shall be subject to the approval of the Architect, Owner and Consultant. Refer to Paragraph 1.05, Samples.
3. Fabricated foodservice equipment shall be manufactured by one manufacturer, of uniform design, material and finish.
4. Equipment shall conform to the applicable requirements of current Federal, State, and Local Codes and Regulations.

B. Welding

1. The words "weld", "welded" or "welding" as used in this Section of the Specification shall mean that metal joints shall be continuously welded and the exposed parts ground smooth and polished to match adjoining surfaces. Welding electrodes shall match the material being welded.
2. Where spot welding is specified, the welds shall be a maximum spacing of 3 in. on center.
3. Where tack welding is specified, the pieces welded shall have 1/2 in. minimum lengths of welding material at 4 in. on center maximum spacing.

C. Grinding, Polishing and Finishing

1. Exposed welding joints shall be ground flush with the adjoining material and neatly finished to harmonize therewith. Wherever material has been depressed or sunken by a welding operation, such depressions shall be suitably hammered and peened flush with the adjoining surfaces and, if necessary, again welded and ground to eliminate low spots. Ground surfaces shall be polished or buffed to a degree consistent with good workmanship. Coves shall be ground and polished to match adjoining material.
2. Care shall be exercised in grinding operations to avoid excessive heating of metal and discoloration. Abrasives, wheels, and belts used in grinding stainless steel shall be iron free and shall have not been used on carbon steel. The texture of the final polishing operation shall be uniform and smooth. Grain direction shall be uniform, uni-directional for a total length of material. Cross grains and random polishing are not acceptable.

3. The general finish of equipment shall be consistent throughout the job. Brake ends shall be free of open texture or orange peel appearance, and where brake work mars the uniform finish of the material, the marks shall be removed by grinding and polishing, and finishing. Sheared edges shall be free of burrs, projections or fins to eliminate all danger of laceration. Mitered or bullnosed corners shall be neatly finished with the underedge of the material neatly ground to a uniform condition and in no case will overlapping material be acceptable. The equipment surfaces, where exposed, shall be finished to a grained Number 4 (satin) finish unless otherwise specified. An exposed surface shall include an inside surface, which is exposed to view when a swinging or sliding door is opened. Underside of shelves need not be satin finish unless otherwise specified.
4. Excessive distortion caused by welding shall be cause for rejection for that item of equipment.

2.03 BUY-OUT COMPONENTS

- A. CASTERS: 5 in. diameter polyurethane tired, swivel, plate or stem mount to suit application, 300 pound capacity, brakes only if specified, NSF approved; Component Hardware C-21-3050 (plate/no brake), C21-3051 (plate/brake) C23-3350 (stem/no brake) or C23-3351 (stem/brake), or equal.
- B. COUNTER LEGS: Stainless steel, 6 in. to 7-3/4 in. height adjustment; Component Hardware A72-0811, or A77-5048, or equal.
- C. DOOR AND DRAWER PULLS: Stainless steel, full grip type with beveled edge, NSF approved for stud mounting in device, in horizontal attitude to meet NSF requirements; Component Hardware P63-1012, or equal.
- D. DOOR HINGES: Stainless steel, lift off type, swedged knuckle for minimum clearance, nylon bearings; Component Hardware M75-1002.
- E. DRAWER PANS: Molded plastic or fiberglass, 20 in. by 20 in. by 5 in. deep, NSF approved; Component Hardware S80-2020, or equal.
- F. DRAWER SLIDES: Stainless steel, NSF approved, full extension, 200 pound capacity with stainless steel ball bearing wheels; Component Hardware S-52 series, or equal.
- G. FAUCET SETS, DECK MOUNTED: Chrome plated cast bronze with 1/2 in. IPS eccentric flanged female inlets on 8 in. centers, removable cartridges, lever handles, and aerator tip on swivel nozzle or swivel gooseneck to suit the application; T&S Brass B-0221 or B-0321, or equal by Component Hardware, Chicago, or Fisher.
- H. FAUCET SETS, POTWASHING SINK: Chrome plated cast bronze with removable cartridges, 3/4 in. passages, eccentric flanged female inlets on 8 in. centers with LL street EL inlets with locknuts, four prong handles, 12 in. swing spout; T&S Brass B-290.
- I. FAUCET SETS, SPLASH MOUNTED: Chrome plated cast bronze with 1/2 in. IPS eccentric flanged female inlets on 8 in. centers, removable cartridges, lever handles, and aerator tip on 12 in. swing spout; T&S Brass, B-0231 or equal by Component Hardware, Chicago, or Fisher. Provide each with a mounting kit.

- J. GUSSETS: Stainless steel, stepped side, fully closed, NSF approved, mild steel interior reinforcement, wide flange for welding to framing, set screw anchor for leg; Component Hardware A20-0206C, or equal.
- K. LEG AND BULLET FOOT ASSEMBLIES: Stainless steel tubing, 16 gauge, number 4 finish, adjustable bullet foot with minimum of 3 in. vertical travel, 2,000 pound capacity, top designed for mounting in gusset, length to suit application; Component Hardware A46-6272-C, or equal.
- L. LEG AND FLANGED FOOT ASSEMBLIES: Stainless steel tubing, 16 gauge, number 4 finish, adjustable bullet foot with 3-1/2 in. diameter flange and two holes for securing to floor, minimum of 3 in. vertical travel, 2,000 pound capacity, top designed for mounting in gusset, length to suit application; Component Hardware A46-4272-C, or equal.
- M. NUTS: Zinc plated "Pal Nuts" with integral cap and lockwasher; Component Hardware Q-34-1024 or equal.
- N. SEALANT: Silicone type sealant for sealing equipment to walls or filling crevices between components, TRANSLUCENT, NSF approved; Component Hardware M90-1010, or Dow Corning 732-RTV.
- O. SOUND DEADENING BASINS: Component Hardware Q75-1366
- P. SOUND DEADENING TOPS AND SHELVES: Component Hardware Q85-5225 "Tacky Tape" installed between all channel or angle reinforced tops, drainboards or undershelves.
- Q. WASTE OUTLETS, CRUMB CUP: Stainless steel body, removable crumb cup stopper, gasket, coupling nut and sealing washer, 1-1/2 in. IPS, and optional 4 in. long nickel plated brass tailpiece with gasket; Component Hardware E38-1010, or equal.
- R. WASTE OUTLETS, LEVER OPERATED: Cast stainless steel rotary type with 1-1/2 in. NPS and 2 in. NPS threads, and removable beehive crumb-cup; Component Hardware DSS-8000.
- S. WELD STUDS: Copper flashed steel with 10-24 threads, length to suit; Component Hardware Q-36, or equal.
- T. GFCI RECEPTACLES: Pass & Seymour 2095-W, 115 volt, 20 amp GFCI Duplex Receptacle or equal.

2.04 FABRICATED COMPONENTS

- A. Box Type Cabinet Construction
 - 1. Sheet metal cabinet bases of box type construction shall be fabricated without general interior framing. Structural strength shall be achieved by the gauge of the metal and the formed angle and channel edges and corners. Vertical sections shall be closed. Cabinet base shall be fabricated of 18 gauge minimum of material specified at Item Specifications. Mount on counter legs or base as specified.

2. Intermediate shelf shall be fabricated of 16 gauge stainless steel with rear and sides turned up 1-1/2 in. tight to the cabinet sides. The front edge of shelf shall be turned down 1-1/2 in. and in 1/2 in. at 45 degrees and shelf spot welded in place. Reinforce underside with longitudinal 14 gauge channel on the centerline.
3. Bottom shelf shall be fabricated of 16 gauge stainless steel similar to the intermediate shelf except that the front edge shall be formed into a full width 1-1/2 in. by 4 in. welded in boxed channel. Rear edge shall be fitted with a full width channel. Underside shall be reinforced.

B. Counters and Drainboards

1. Counters, table tops and drainboards shall be 14 gauge stainless steel, of NSF construction, with edges per Item Specifications. Metal tops shall be made of the largest pieces available and shall appear as one piece with all field and shop joints reinforced and welded, ground and polished. Short pieces of metal will not be acceptable. Counter bends shall be not less than 1/8 in. radius. Wherever a fixture has a waste or drain outlet, the surface shall pitch toward the outlet.
2. Counters, table tops and drainboards shall be reinforced with channel or angle frame as specified in the Item Specifications. Framing shall be secured to the underside with sound deadening material sandwiched between the surfaces, weld studs, and nuts.
3. Wherever bolts or screws are welded to the underside of trim or tops, neatly finish the reverse side of the weld uniform with the adjoining surface of the trim or top. Depressions at these points will not be acceptable. Raise dimples and depressions by peening, or heating and shrinking, and grind and polish to present a flat surface.

C. Crossrails

1. Crossrails shall be not less than 1-1/4 in. outside diameter 16 gauge stainless steel tubing welded, ground and polished to a Number 4 finish. Crossrails shall be welded to legs at a height of 10 in. above finished floor, and shall extend from left to right between front legs, unless otherwise specified, and from front to back between all legs.

D. Drawer Assembly

1. Drawer assemblies shall consist of a removable drawer pan set in a removable 16 gauge stainless steel channel shaped drawer support frame with gusset plate reinforced corners.
2. Support frame shall have double pan front cover consisting of boxed 18 gauge stainless steel outer shell with welded corners, flush mounted recessed stainless steel pull, 20 gauge stainless steel back shell tack welded to outer shell with fiberglass sound deadening between. Drawer shall be provided with rubber bumpers to quiet closing. Support drawer frame on full extension drawer slides.
3. Drawer shall be suspended from table in a three-sided, 16 gauge stainless steel enclosure with flanged-in bottom edges, banded lower front, flanged-out front side and top edges. All sharp corners shall be broken and any exposed exterior threads of slide mounting bolts shall be provided with solid metal acorn nuts.

4. Component Hardware S91-0020 with thermoplastic pan is considered as equivalent to the above specified construction.

E. Edges

1. Marine: Bumped up 1/2 in. at 45 degrees and turned down 1-1/2 in. and in 1/2 in. at 45 degrees; corners welded and square.
2. Raised roll: Covered up and rolled 180 degrees on a 1-1/2 in. diameter with 3 in. height; corners welded and rounded or covered.
3. Rolled: Rolled 180 degrees on a 1-1/2 in. diameter; corners welded and bullnosed.
4. Short (6 in.) splash on counters and tables: Covered up 6 in., turned back to wall or equipment 1 in. and down 1/2 in.; ends welded closed. Secure tight to face of wall with clips unless specified otherwise and seal joint.
5. Tall (10 in.) splash on preparation sinks, dishtables, counter, and tables: Covered up 8-1/2 in., turned back to wall or equipment 1-1/2 in. at 45 degrees and down 1/2 in.; ends welded closed. Secure 3 in. off face of wall with brackets unless specified otherwise.
6. Turn down: Turn down 2 in. and in 1/2 in. at 45 degrees; corners welded and square.

F. Framing of Tops, Drainboards, Undershelves

1. Channel: Reinforce with 1 in. by 4 in. by 1 in. 14 gauge galvannnealed steel channels; stainless steel if exposed to view. Channels shall run front-to-back at all legs and longitudinally on the centerline. Cross and longitudinal members shall be welded into a single assembly at intersections and sharp corners shall be broken. Framing shall be secured to underside of tops with pairs of weld studs. Framing shall be installed maintaining NSF required clearance to adjacent vertical surfaces and edges of top. The following specified angle framing is considered superior to channel framing and may be used in its place.
2. Angle: 1-1/2 in. by 1-1/2 in. by 1/8 in. perimeter angle frame with crossmembers not over 30 in. on center. Framing shall be secured to top with weld studs, 18 in. on center maximum with three minimum studs on any single face of a table. Perimeter angle frame that is exposed to normal view, shall be stainless steel. Crossmembers and framing not unexposed to normal view shall be iron. Corners of angle frame shall be mitered, or notched and brake formed to form a closed corner. Corner gusset plates used for mounting of leg gussets shall be 1/8 in. thick and sealed to underside of the top. Iron framework joints shall be ground smooth, and shall be painted with a minimum of two coats of aluminum lacquer after degreasing. Framing shall be installed maintaining NSF required clearance to adjacent vertical surfaces and edges of top. Channel framing shall not be considered equal to specified angle framing.
3. Sound deaden all horizontal framed surfaces with material sandwiched between the framing and the bottom of the surface.

G. Hinged Doors

1. Hinged doors shall be double pan type stainless steel construction with 18 gauge exterior and 20 gauge interior, welded corners, and 1/2 in. fiberglass insulation for sound deadening. Each door shall be provided with a stainless steel recessed handle, and an adjustable tension door catch equal to Component Hardware M22-2430. Doors shall close against the bottom shelf and flush with body of equipment.
2. Louvered hinged doors for ventilation shall be fabricated of the same components and provided with a full perimeter 3 in. wide channel reinforcing frame on the interior face. Remaining face shall be die punched with drip-proof louvers fully utilizing the remaining flat metal or a stainless steel flattened expanded metal grille per Item Specifications.

H. Sinks and Sink Inserts

1. Unless otherwise specified, sinks including sink inserts built into tops of fixtures, shall be made of 14 gauge stainless steel with all vertical and horizontal corners rounded to a radius of approximately 3/4 in. with the intersections meeting in a spherical section. Sinks shall be integrally welded to fixture tops.
2. Sinks with two or more compartments shall have full height, 1 in. thick double wall partitions consisting of two pieces of stainless steel back-to-back so fabricated that each compartment will be a deep bowl with coved corners. Partitions shall be welded in place to the bottom, front and back of the sink with smooth rounded coved corners. Top edges of the partitions shall be continuously welded. The front of the sinks shall consist of a stainless steel smooth, flush apron, same gauge as the sinks. Bottom and rear of partitions shall be closed. Sink dimensions contained in Item Specifications are inside dimensions.
3. Sinks shall be provided with integral 14 gauge stainless steel drainboards when specified. Drainboards and sink basins shall be pitched toward waste outlets and shall be self draining. The underside of all sink basins shall sound deadened. Sink units shall be provided with an integral splash at walls. Provide the necessary holes for the mounting of faucet sets.

I. Sliding Doors

1. Sliding doors shall be double pan type stainless steel construction with 18 gauge exterior and 20 gauge interior, welded corners, and 1/2 in. fiberglass insulation for sound deadening. Each door shall be provided with a stainless steel recessed handle. Provide sliding doors with nylon roller bearing sheaves and overhead track components equal to Component Hardware B58-5523 and 5513 sheaves, B57 track, B62-1093 nylon door guides and B60-1086 door stops.

J. Undershelves

1. Undershelf in an open type table shall be 16 gauge stainless steel unless otherwise noted. Edges shall be turned down 1-1/2 in. and in 1/2 in. at 45 degrees with corners notched out to fit legs to which shelf shall be welded from underside. Line up all edges of shelf with centerline of legs. Reinforce underside with longitudinal 14 gauge channel on the centerline.

K. Wall Brackets

1. Dish tables, sinks and counters with sinks shall be securely anchored 3 in. off the face of the wall unless specified otherwise. Brackets shall be "Z" shaped and fabricated of 3 in. wide, 14 gauge stainless steel. Brackets shall be secured in a vertical attitude to the rear of equipment backsplash with weld studs, and to the wall with appropriate fasteners.
2. Counters that are specified tight-to-wall shall be secured in a hidden manner with steel clips, and the wall/fixture joint shall be sealed.

L. Wall Shelves

1. Wall shelves shall be fabricated of 16 gauge stainless steel, size per Item Specifications, with back and ends raised 1-1/2 in., front edges of ends angled back, all corners broken, and front turned down 1-1/2 in., and in 1/2 in. at 45 degrees. Shelf corners shall be welded, ground and polished. Mount shelf 1 in. off face of wall with suitable fasteners on 14 gauge stainless steel flag brackets, 48 in. on center maximum. Flag brackets shall have a web angle of 30 degrees, measured from horizontal.

2.05 ELECTRICAL EQUIPMENT AND WIRING

- A. Under this Section, items of equipment having mounted electrical motors, electrical heating units, lighting fixtures, controllers, control stations, switches, receptacles and the like shall be internally wired as specified herein, terminating at a junction box mounted on the equipment and left ready for connection to the building electrical distribution system by the Electrical Contractor. Extra ceiling mount light fixtures for refrigerated rooms shall be delivered to Electrical Contractor for field installation and wiring. Connections to evaporator coils mounted inside refrigerated rooms shall be wired by the Electrical Contractor.
- B. Provide openings or cutouts required to accommodate the switches and receptacles in the specified work, and the wiring in conduit from terminal blocks in junction boxes.
- C. Electrically operated equipment and fabricator wiring shall conform to the requirements of Underwriter's Laboratories, Inc. Motors over one horsepower shall be equipped with overload protection.
- D. Furnish wiring diagrams for equipment as requested by the Architect or Contractor.

2.06 ITEM SPECIFICATIONS

Item 1

FIXED STORAGE SHELVING, FIVE-TIER

Quantity - 5

Make - Metro Super Adjustable Super Erecta

Size - (4) 60" x 21", (1) 36" x 21" x 74-5/8" high; five tier with bottom shelf up 14" clear above floor

Description - Unit shall be all standard construction with Super Adjustable Chrome plated wire shelves and tubular steel uprights with capped tops, adjustable feet, and 1" shelf height adjustment capability with Corner Release System. Each unit shall include four legs.

Item 2

MOBILE TRANSPORT CART

Make - Lakeside 521 or equal by Kelmax or Channel

Size - 32-5/8" x 19-3/8" x 34-1/2"

Description - Cart shall be all standard NSF construction, stainless steel throughout, with top and bottom shelves supported by an angle frame, and mounted on two 8" fixed and two 5" swivel casters. Capacity of cart to be 650 pounds.

Item 3

SODA SYSTEM

No work in this Section. Units provided by Vendor.

Item 4

Spare number

Item 5

Spare number

Item 6

SLICER, NOT SHOWN ON PLAN

Make - Hobart HS9 or equal by Bizerba or Globe

Power - 5 amps - 1/2 HP - 120/60/1 - cord and plug

Description - Slicer shall be all standard construction, automatic type with anodized cast aluminum housing and base, removable 13" diameter 304L stainless steel knife with removable ring guard cover, totally enclosed, permanently lubricated PSC knife motor, with poly-v belt drive, zero knife exposure, linear automatic carriage drive system with speeds of 28, 38, 48 and 58 strokes per minute, manual assist mode, and provided with thermoplastic coated steel feed grip, glass bead finished gauge plate and knife cover, tilting carriage, water protected push-button switches, top mounted and removable knife sharpener with two borazon stones, adjustable gauge plate from "0" to 1", lift lever system and rubber feet. Unit to be provided with mechanical and electrical interlocks to include home position start, close gauge plate to stop, carriage will not tilt away or remove if gauge plate is not closed, locked gauge plate when carriage is removed, no-volt release, and 30 second automatic shut-off without carriage motion. Slicer shall be NSF 8 compliant.

Accessories - Provide unit with knife removal tool

Item 7

Spare number

Item 8

REACH-IN DUAL TEMPERATURE REFRIGERATOR/FREEZER, TWO-DOOR

Make - True STR2DT-2S or equal by Victory, Continental or Traulsen

Size - 52-5/8" x 33-3/4" x 77-3/4" high overall

Power -11.6 amps - 120/60/1 - cord and plug

Doors - Full height, standard hinging

Description - Refrigerator/Freezer shall be all standard construction with stainless steel exterior, stainless steel coved interior floor, white aluminum interior walls, self-closing door hardware with magnetic gaskets and locks, polyurethane insulation, automatic interior lighting, exterior digital thermometer, chrome plated wire shelves, self-contained capillary tube controlled top mounted refrigeration system capable of maintaining a 33° to 38° temperature range in the refrigerator and -10° in the freezer section, condensate evaporator included. Mount unit on 5" diameter swivel casters with brakes at front.

Accessories - Provide kit #3 universal tray slides behind the refrigerator door.

Item 9

FIRE SUPPRESSION SYSTEM

Make - Ansul R-102

Protection for hood: 10

Design - Provide an automatic liquid fire suppressant system sized to meet all local codes, UL 300 and NFPA Codes. System shall provide surface protection for cooking equipment, hood and the exhaust duct work, if required. Tanks shall be mounted on wall per plan, 78" high to bottom and within a 16-1/2" x 23-1/2" x 7-1/2" high stainless steel cabinet and piping shall run hidden wherever possible. All pipes and fittings used to convey the chemical shall be scale free steel, 40 weight. Exposed piping located within the ventilator shall be stainless steel or chrome and limited to vertical drops only. Horizontal piping shall be run over the ventilator's top. Nozzles shall be swivel type with metal caps. Detection shall be fusible links rated per codes, and system shall rely on no outside source of power. The system shall be provided with a control box with indicator to indicate system status. Control head shall also include integral micro switch offering "normally open" and "normally closed" terminals for use by the Electrical Contractor for the shut-down of equipment and the sounding of alarms, etc. Suppressant tanks shall be stainless steel. Provide a properly sized mechanically operated gas shut-off valve (up to 3" diameter) for mounting by the Plumber at a point in the gas supply that will shut off fuel to all gas fired equipment. Provide and install a remote pull station per codes, complete with cables, conduit and pulleys. Coordinate installation of remote pull station with General Contractor to provide a recessed junction box mounted for installing the pull box with cable conduit concealed within walls. Provide system with class-K extinguisher as required.

Workmanship - Exposed stainless steel fittings and piping shall be assembled with special care to avoid marring or damaging the surfaces. Any pieces showing marks shall be removed and replaced with new materials. Chrome sleeves are not acceptable.

Test - Perform a puff test on the completed system and obtain the written approval of the local Fire Inspector.

Accessories - Provide metal caps on the nozzles.

Item 10

EXHAUST VENTILATOR

Make - AquaMatic AM-ND-2

Size - 6'- 8" x 60" x 24" high plus A 4" high collar, mounted up 6'-8" above finished floor; flat bottom

Power - 0.2 KW - 120/60/1 to lights; remote switch provided and installed by Electrical Contractor.

Exhaust - 1,690 CFM exhaust through a 16" x 10" collar at 0.635" static pressure. Blower and ductwork provided and installed by Ventilation Contractor.

Description - Ventilator shall be of all standard construction, built of not less than 18 gauge 304 stainless steel throughout with welded joints and seams in accordance with NFPA-96, with reinforced front bottom edges with integral front baffle, double wall insulated fronts, and NSF Listed. Units shall have grease collection troughs, storage containers, and hanger brackets. Provide with 430 stainless steel Captrate Grease-Stop Solo Filter UL classified S-baffle extractors that shall remove at least 75% of grease particles five microns in size, and 90% of grease particles seven microns in size and larger, with a corresponding pressure drop not to exceed 1.0 inches of water gauge. Provide all materials necessary for the hanging of the ventilator.

Accessories - Provide unit with TWO UL Listed light fixtures with LED, factory prewired and left ready for final connection by the Electrical Contractor. Provide closure trim per detail to a point 3" above finished ceiling to close to adjacent surfaces on two sides.

Item 10A

EXHAUST FAN MANAGEMENT SYSTEM

Make - CaptiveAire DCV or equal by or equal by Caddy or Gaylord

Power - 20 amps circuit - 120/60/1 to logic controller

Scope - Furnish and install complete exhaust control system for the exhaust canopy in accordance with the plans and Manufacturers shop drawings. The system shall include programmable logic controller (PLC), variable frequency drive (VFD), stainless steel control enclosure, exhaust duct temperature sensors, room temperature sensor, LCD screen interface with cable, all specified accessories, and those components required to provide complete and satisfactory systems in accordance with accepted HVAC practice. System shall control Item 10. Mount LCD screen control, recessed and flush to wall per plan 60" above floor. Mount LCD screen control in a recessed junction box provided by the general contractor.

Important: The installation work shall be performed by a fully qualified contractor employing a certified mechanic fully trained in the installation of the DCV hood system. Submittal shall list the installing company and the qualified system installer. Provide wiring diagrams and guidance to related trades to achieve correct operation of the system.

Accessories - Provide BacNet monitoring system.

Item 10B

CONTROL PANEL, WALL MOUNTED

Part of item 10

Item 10C

ROOM TEMPERATURE SENSOR

Part of item 10

Item 11

TILED WALL

No work in this Section. Units provided by General Contractor.

Item 12

Spare number

Item 13

FRYER WITH OIL FILTRATION SYSTEM

Make - Pitco SSH55-SSTC-S/FD*C166

Size - 15-5/8" x 34-3/8" x 34" high to rim

Power - 0.7 amps - 120/60/1 - cord and plug

7 amps - 120/1 - cord and plug (for filter system)

Rating - 3/4" gas inlet at 80,000 BTU/Hour

Description - Fryer shall be unit of all standard construction and shall be complete with stainless steel body, splash, top and fryer pots, blower free atmospheric burner system, self cleaning thermostatically controlled burners and solid state fail-safe thermostats. Mount unit on 10" legs.

Accessories - Provide assembly with a 36" long x 1" line size Dormont 16100 KIT2S plastic covered hose assembly with full port gas ball valve, two Supr-Swivels, brass disconnect, 90° street elbow and restraining cable. Mount the nipple on the rear of the unit, and the hose assembly with disconnect device connected to the building supply line. Provide assembly with four twin sized baskets. Provide unit with a built-in filter drawer system, flush hose and provide 100 filter bags.

Item 14
Spare number

Item 15
CONVECTION OVEN BASE EQUIPMENT STAND

Make - Jade js1b-036-60C*C166

Size - 60" x 30" x 25-1/4" high plus 3" casters

Rating - 3/4" rear gas inlet at 30,000 BTU/Hour

Power - 8 amps - 120/60/1 - cord and plug

Description - Oven shall be all standard construction with 14 gauge welded body, 300 series stainless steel front and sides. Bottom shall be fitted with an insulated, stainless steel lined oven, 27-3/4" x 20-1/2" x 13-1/2" high, complete with thermostatic controls with a temperature range from 150° to 500° F, automatic ignition and 100% safety pilot, three rack positions, and two chrome plated oven racks. Rear shall be finished in enameled steel.

Accessories - Mount unit on 3" diameter heavy duty swivel casters with brakes at front, stainless steel side panels and a 36" long x 3/4" line size Dormont 1675 KIT2S plastic covered hose assembly with full port gas ball valve, two Supr-Swivels, brass disconnect, 90° street elbow and restraining cable. Mount the nipple on the rear of the oven, and the hose assembly with disconnect device connected to the building supply line.

Item 16
OPEN BURNER RANGE, COUNTER-TOP

Make - Jade JHP-424*C166

Rating - 3/4" gas connection at 80,000 BTU/hour

Description - Range shall be all standard construction with 14 gauge welded body, 300 series stainless steel front, two cast iron sections, each containing individually controlled 20,000 BTU/hour burners, stainless steel pilot burners, and full width removable spillover tray. Ends and rear shall be finished in enameled steel.

Accessories - Mount on stainless steel legs and provide a pressure regulator. Provide unit with a 36" long x 3/4" line size Dormont 1675 KIT2S plastic covered hose assembly with full port gas ball valve, two Supr-Swivels, brass disconnect, 90° street elbow and restraining cable. Mount the nipple on the rear of the range, and the hose assembly with disconnect device connected to the building supply line. Provide an 8" deep poly cutting board.

Item 17
THIRTY-ONE INCH CHARBROILER, COUNTER-TOP

Make - Jade JB-30*C166

Rating - 3/4" rear gas connection at 75,000 BTU/hour

Description - Broiler shall be all standard construction with 14 gauge stainless steel body, cast iron radiants, five individually infinitely manually controlled burners, 12 gauge welded firebox, a 14 gauge drip pans and standard stub back.

Accessories - Mount on stainless steel legs and pressure regulator. Provide unit with a 36" long x 3/4" line size Dormont 1675 KIT2S plastic covered hose assembly with full port gas ball valve, two Supr-Swivels, brass disconnect, 90° street elbow and restraining cable. Mount the nipple on the rear of the broiler, and the hose assembly with disconnect device connected to the building supply line.

Accessories - Provide an 8" deep poly cutting board

Item 18
Spare number

Item 19
Spare number

Item 20

REFRIGERATED SANDWICH PREP TABLE

Make - True TSSU-36-8*C166 or equal by Beverage-Air or Continental

Size - 27-5/8" x 30-1/8" x 36-3/4" high to work surface

Power - 4.9 amps - 1/3 HP - 120/60/1 - cord and plug

Drawers - two

Description - Refrigerator shall be all standard construction with stainless steel top, front and ends, aluminum back, foamed-in-place polyurethane insulation, heavy duty stainless steel drawer slides and rollers, white vinyl coated aluminum interior with stainless steel floor, slide-out air cooled refrigeration system with thermostatic controls and condensate evaporator, and top fitted with a 11-3/4" wide reversible white plastic cutting board, and an eight pan opening complete with hinged insulated stainless steel cover assembly, adapter bars and a full set of 4" deep 1/6 size pans. Mount on 5" swivel casters.

Accessories - Provide unit with five year compressor warranty and double overshef.

Item 21

WORK COUNTER WITH HAND SINK

Make - Fabricate per General Construction this Section by Allstate, Carbone or Custom Metals of MA.

Size - 60" x 30" x 36" high plus 6" high splash at wall; 10" x 14" x 5" deep integral sink basin with side splashes.

Construction - 14 gauge stainless steel top, basin and splash over angle frame and mounted on a stainless steel cabinet base of box type construction with bottom shelf, partial intermediate shelf, and mounted on 6" high adjustable legs. Provide neatly punched hole in undershef for passage of drainline. Front and ends of top shall be formed in a turndown; rear in a short splash. Secure to wall and seal. Provide an apron at the sink with reinforced bottom edge.

Accessories - Provide a 3" flat strainer type (non-basket, non-lever) open type waste, chrome plated tailpiece, "P" trap and clean-out cap. Provide 6" high welded side splashes with sloping ends and radius corners.

Item 21A

FAUCET

Make - T&S Brass B-0892

Description - Unit shall be all standard construction with mixing body, 4" center inlets, wrist blade handles. Modified unit shall be provided with 119X gooseneck with B-0199-02F-12 aerator tip in lieu of the standard.

Item 22

Spare number

Item 23

WALL SHELF

Make - Fabricate per General Construction this Section by Allstate, Carbone or Custom Metals of MA.

Size - 60" x 10" mounted 54" above floor

Construction - Wall shelf shall be fabricated of 16 gauge stainless steel with back and ends raised 1-1/2", front edges of ends angled back, all corners broken, and front turned down 1-1/2", and in 1/2" at 45°. Shelf corners shall be welded, ground and polished. Mount shelf 1" off face of wall with suitable fasteners on 14 gauge stainless steel flag brackets, 48" on center maximum. Flag brackets shall have a web angle of 30° measured from horizontal.

Item 24

WORK COUNTER

Make - Fabricate per General Construction this Section by Allstate, Carbone or Custom Metals of MA.

Size - 9'-6" x 30" x 36" high plus 6" high splash at wall

Construction - 14 gauge stainless steel top and splash over angle frame and mounted on a stainless steel cabinet base of box type construction with bottom shelf, partial intermediate shelf, and mounted on 6" high adjustable legs. Provide neatly punched hole in undershelf for passage of drainline for the soda dispenser. Front and ends of top shall be formed in a turndown; rear in a short splash. Secure to wall and seal

Item 25

SOFT SERVE ICE CREAM DISPENSER

Make - Taylor 161

Size - 21" x 25-3/4" x 27-3/4" high overall, plus 4" legs

Power - 12 Amps - 208/60/1 - cord and plug

Description - Freezer shall be all standard construction with twin eight quart insulated hoppers, TQC control system, 1-1/2 quart freezing cylinders, thermoplastic doors, self contained air cooled refrigeration systems and mounted in a stainless steel exterior cabinet.

Accessories - Provide unit with cord and plug set, mix low lights, a self-service package and legs.

NOTE - Verify product to be served (soft serve or frozen yogurt) with the operator and provide machine set for the selected product.

Item 26

Spare number

Item 27

SODA AND ICE DISPENSER

No work in this Section. Units provided by Vendor.

Item 28

Spare number

Item 29

SERVERY COUNTER

Make - Fabricate per General Construction this Section by Allstate, Eagle, or Custom Metals of Mass.

Size - 42" x 36" x 34" high

Construction - See item 34 for the description and refer to the drawing details and elevations.

Item 30

REFRIGERATED DISPLAY CASE

Make - Regal Pinnacle Integrations, Lexington SCBD48R

Size - 48" x 35-3/4" x 50" high

Power - (9.9 amps) 1/3 HP - 120/1

Description - Unit shall be constructed per the manufacturer's standard specifications consisting of a refrigerated cabinet containing two stainless steel shelves with lights, mirror ends, fixed curved insulated front glass display window, see through mirrored rear sliding doors and a stainless steel deck pan. A self-contained refrigeration system with rear air intake and discharge and a built-in condensate evaporator pan. Built in accordance with NSF 7 and UL listed. Provide a thermometer.

Accessories - Provide LED lights and a stainless steel exterior with a number 4 finish.

Item 31
POINT OF SALES SYSTEM
No work in this Section. Units provided by Owner.

Item 32
DROP-IN SOUP WELLS
Quantity - 2
Make - Cook-Tek ISW061*C166
Size - 12-1/2" diameter x 10-1/2" deep
Power - 7.5 amp - 120/60/1 - NEMA 5-15P cord and plug
Description - The drop-in soup well shall be all standard construction per the manufacturer's details with an aluminum housing, high impact polycarbonate top and stainless steel top ring. Unit features automatic pan detection, four standard temperature settings (150, 160, 175, 190° Fahrenheit), independent re-therm settings, integral alarm and boil dry warning. The remote control panel includes an on/off switch, adjustable temperature control, red LED display screen and is supplied with a 7'-0" shielded cord. The power cord is 6'-0" in length.
Accessories - Provide a brain marie insert model BM11T and BM7ADT.

Item 33
VERTICAL BREATH GUARD
Make - Versa-Gard VP24.3*C166
Size - Approximately 72" long x 26" high
Description - Breath guard shall be all standard construction with three front uprights with brushed stainless steel finish and tempered glass front panels. Glass shall have beveled and polished exposed edges. Unit shall be built in accordance with NSF/ANSI 2 - 2008. Mount to counter top from below using concealed mount style hardware option 4.2.

Item 34
SERVERY COUNTER
Make - Fabricate per General Construction this Section by Allstate, Eagle, or Custom Metals of Mass.
Size - 12'-3" x 36" x 34" high

Power -
One - 20 amps - 120/60/1 to apron mounted GFI outlet at the right end
Three - 20 amps - 120/60/1 to body mounted GFI outlets

Construction - 14 gauge stainless steel top over angle frame with all edges turned down 2" and corners welded. Provide raw openings for the soup wells item 32.

Mount on eight 2" square 16 gauge stainless steel tubular legs with Component Hardware A15-0851 adjustable feet. Reinforce between all front and end legs with 2" square stainless steel tubing welded in place 6-1/4" clear above floor.

Undershelves shall be fabricated of 16 gauge stainless steel with reinforcing and sound deadening as specified for open base table undershelves. Front face shall be turned down 1-1/2" and in 1/2" at 45°. Rear and ends shall be turned up 1-1/2" and corners welded. Weld to legs at a point 10" above floor. Shelf shall be mounted on the inside face of legs, not cut-out at each leg. Leave 2" clearance between the shelf edge and the counter front and end panels for passing of services by Related Trades.

Front and exposed ends of counter shall be provided with a 3/4" plywood substrate for mounting the spectrum panels. The spectrum panel manufacturer and finish color shall be as selected by the Architect. The substrate shall be secured to counter legs and crossrails with welded stainless steel clips and stainless steel wood screws. Do NOT secure THROUGH the legs or crossrails. Provide a continuous 14 gauge support-protector strip at the lower edge of all finish panels, extending 1/16" past front face.

Apron shall be provided per elevations, fabricated of 18 gauge stainless steel, and shall be used for the mounting of switches, outlets, and controls. Apron shall include a formed reinforced bottom edge and shall be set in 1" from leg face.

Item 35
Spare number

Item 36
MILLWORK COUNTER
No work in this Section. Units provided by General Contractor.

Item 37
INSTANT COFFEE BREWER
No work in this Section. Units provided by Vendor.

Item 38
UNDER COUNTER REFRIGERATOR
Make - Perlick HD24RS
Size - 23-7/8" x 18" x 32" high
Power - 2.3amps - 120/1 (NEMA 5-15)
Description - Unit shall be all standard construction per the manufacturer's details with stainless steel front, top, sides and complete interior; a self closing door and 2" foam in place insulation. A 1/6 horsepower hermetic compressor unit using R-134a capillary tube type refrigeration to maintain a temperature range between 33°-39° F degrees. Includes two coated wire shelves and a condensate evaporator pan.

Item 39
WATER AND ICE DISPENSER WITH FILTER
Make - Follett 15 Series 15CI100A-IW-CF-ST-00
Size - 14-3/4" x 23-1/2" x 22-1/2" high
Power - 5 amps - 120/60/1 - cord and plug
Capacity - 125 pounds daily production with 15 pounds of storage
Description - Icemaker and water dispenser shall be all standard construction with stainless steel body with black accent trim, a removable drain pan, polyurethane insulated bin with 15 lbs storage capacity. Energy star rated air-cooled icemaker with R134A system shall produce approximately 125 lbs. of Chewblet ice per day.
Accessories - Provide three replacement filter cartridges.

Item 40
Spare number

Item 41
BAR TOP, DIE WALL AND SHELVES
No work in this Section. Units provided by General Contractor.

Item 42

UNDER COUNTER ICE MAKER

Make - Scotsman CU50*C166 or equal by Manitowoc

Size - 15" x 22-1/2" x 34-1/4" high

Capacity - 65 pounds per day at 70/70 with built-in 26 pound storage bin

Power - 15 amp circuit - 120/60/1 - cord and plug

Description - Icemaker shall be standard construction with air cooled refrigeration system with front air grille, stainless steel cabinet exterior, and tilt-out insulated bin. Machine shall be automatic with bin level thermostat, and produce individual cubes on a stainless steel open cell evaporator. Provide unit with standard two year parts and labor warranty.

Item 42A

WATER FILTER

Make - 3M ICE120-S

Size - 4" diameter x 17" verify clearance below to remove cartridge

Description - Unit shall be all standard construction and consist of a head assembly with integral mounting bracket, quarter-turn cartridge release mechanism, "valve-in-head" automatic shut-off upon removal of cartridge, pressure gauge, and filter cartridge with internal pre-filter membrane designed for ice makers. Cartridge shall be capable of removal to .5 micron or larger particles, remove chlorine and off tastes and odors, inhibit scale build-up, service flow rate of up to 1.5 gallons per minute, and meet requirements of NSF Standards 42 and 53 and be so listed.

Accessories - Provide three spare filter cartridges

Item 43

UNDER COUNTER REFRIGERATOR

Make - Perlick BBS336*C166

Size - 36" x 24-3/4" x 34-9/16" high

Power - 3.2 amps - 120/60/1

Capacity - 7.4 cubic feet

Description - Refrigerator shall be all standard construction with stainless steel front, top, sides, door and interior liner, right hand mounted thermostatically controlled, air cooled self contained refrigeration system with automatic defrost, a digital thermometer, a stainless steel door with polished hardware. Provide door with a white vinyl coated shelf and LED lights. Mount on the floor and coordinate with adjacent Millwork.

Accessories - Provide door lock, five year compressor and one year part and labor warranty.

Item 44

UNDER COUNTER GLASS WASHER WITH INTERNAL BOOSTER HEATER

Make - Perlick PKHT*C166

Size - 24" x 27-1/2" x 33" high plus 6" legs

Power - 50 amp service - 208/60/1

Capacity - Thirty 20" x 20" glass racks per hour

Description - Glasswasher shall be all standard construction, stainless steel throughout, complete with front, top and side panels, 6" high adjustable legs, wash and rinse tanks, 11-1/4" interior height and raised wash chamber, pumped recirculated wash and rinse sprays with spray boxes, front mounted digital LED controls, thermostatically controlled tank heat, low water cut-off, wash and rinse thermometers,

Accessories - Omit the legs and mount on skids.

Item 45

SOAP DISPENSER

No work in this Section. Units provided by Vendor.

Item 46
HAND SINK

No work in this Section. Units provided by General Contractor.

Item 47
COUNTER-TOP AND CABINET BASE

No work in this Section. Units provided by General Contractor.

PART 3 - EXECUTION

3.01 SANITATION REQUIREMENTS

- A. Equipment specified herein shall be fabricated to conform to the "Food Service Equipment Standards" of the National Sanitation Foundation prepared by the Committee on Food Service Standards, and published by the National Sanitation Foundation, Ann Arbor, Michigan. Any differences of opinion on sanitation shall be referred to the State Department of Health for a ruling.
- B. Equipment shall be installed in accordance with the manufacturer's instructions and the best practices of the food service industry, with careful attention to eliminating all cracks, crevices and concealed spaces in wet areas that would be difficult to clean or keep free of vermin and soil.

3.02 EXAMINATION AND ACCEPTANCE

- A. Determine whether the General Contractor will furnish and provide temporary power and light, openings and storage space to permit scheduled delivery of equipment. Verify water pressure and provide necessary reducing valves.
- B. Examine space in which specified work is to be installed to assure that conditions are satisfactory for the installation of specified work. Report in writing to the Architect, any deficiency in the work of other contractors affecting specified work. Commencement of specified work shall be construed as acceptance of space conditions.
- C. Obtain and verify all measurements and conditions on the job, and assume responsibility in respect to same.
- D. Inspect flooring and raised concrete bases, wall finishes, painting, ceiling installation and all related work for readiness to commence installation of foodservice equipment. Verify the existence of required mechanical and electrical rough-ins.

3.03 CLEANING UP

- A. Debris and surplus materials resulting from installation work shall be removed promptly as work progresses, to a location indicated by the General Contractor.
- B. Following completion, and before final acceptance by the Owner, clean finished surfaces in accordance with the manufacturer's instructions, and leave specified work free of imperfections.

3.04 DEMONSTRATION AND OPERATING INSTRUCTIONS

- A. Before final acceptance, and by appointment with the Owner and his representatives, completely demonstrate with power, the correct operation of each new item of operating equipment.
- B. Prior to the demonstration, turn on all mechanical and electrical foodservice equipment. Test for leaks, poor connections, and inadequate or faulty performance and correct if necessary. Adjust for proper operation. Thermostatically controlled equipment and equipment with automatic features shall be operated for a sufficient length of time with proper testing equipment to prove controls are functioning as intended. Recalibrate thermostats if necessary.
- C. Provide Architect or Consultant with a loose leaf bound manual of operating data and maintenance instructions containing complete description, wiring diagrams, operating data, maintenance requirements and other information pertaining to the proper operation and upkeep of the various items of electrical or mechanical equipment. Include names, addresses and telephone numbers of authorized service agencies for all items. Arrange all material in alphabetical order by Manufacturer. Book shall be turned over to Owner after review and approval.
- D. Submit guarantees and warranties to the Architect in the above specified manual with all warranty cards completed and becoming effective at the time the equipment was satisfactorily demonstrated.

3.05 PROTECTION OF WORK

- A. Protect specified work from damage during transportation to the project site, storage at the site, during installation, and after completion until acceptance by the Owner.
- B. Protect adjacent work under other contracts during installation until completion of specified work. After completion, the contractor for other work shall be responsible for the protection of his work until acceptance by the Owner.
- C. Damaged work as determined by the Architect, shall be repaired or replaced as determined by and to the satisfaction of the Architect.

END OF SECTION

SECTION 12 35 30
RESIDENTIAL CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Kitchen cabinets.
- B. Vanity cabinets.
- C. Casework hardware.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing.
- B. Section 11 31 00 - Residential Appliances.
- C. Section 12 36 00 - Countertops.
- D. Division 22 - Plumbing.
- E. Division 26 - Electrical.

1.03 REFERENCE STANDARDS

- A. KCMA A161.1 - Performance and Construction Standard for Kitchen and Vanity Cabinets; Kitchen Cabinet Manufacturers Association; 2012 (ANSI/KCMA A161.1).
- B. KCMA (DIR) - Directory of Certified Cabinet Manufacturers; Kitchen Cabinet Manufacturers Association; current edition, online.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, configurations, and construction details.
- C. Shop Drawings: Indicate casework locations, large scale plans, elevations, clearances required, rough-in and anchor placement dimensions and tolerances.
- D. Samples: Submit two panel boards, 8 x 8 inch in size, illustrating each color of finish.

1.05 QUALITY ASSURANCE

- A. Products: Complying with KCMA A161.1 and KCMA Certified.
- B. Manufacturer: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Residential Casework:
 - 1. Basis of Design: Norich by Echelon Cabinetry.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

- A. Cabinet Construction: Softwood lumber framing and particle board.
- B. Countertops: As specified in Section 12 36 00.
- C. Door and Drawer Fronts: Solid wood.
- D. Bolts, Nuts, Washers and Screws: Of size and type to suit application.
- E. Concealed Joint Fasteners: Threaded steel.

2.03 HARDWARE

- A. Hardware: Manufacturer's standard unless otherwise specified.

- B. Drawer and Door Pulls: Chrome, 4 inches wide.
 - 1. Model: Selected from manufacturer's full line
 - 2. Hardware to meet ADA regulations.
- C. Catches: Magnetic.
- D. Drawer Slides: Extension arms, steel and ball bearing construction.
- E. Hinges: European style.
- F. Shelf Supports: Injection molded clear polycarbonate with integral molded lock tab; 5mm double pin engagement to bored hole in cabinet; 200 lb per clip load rating; 4 point shelf supports; shelves over 27" shall have 5 point support

2.04 FABRICATION

- A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.
- B. Fabricate corners and joints without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.
- C. Fabricate each unit to be rigid and not dependent on building structure for rigidity.
- D. Provide cutouts for plumbing fixtures, appliances, and fixtures and fittings. Prime paint contact surfaces of cut edges.
- E. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

2.05 FINISHES

- A. Selected from manufacturer's full line.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of support framing. Verify type of support framing for determination of proper fastener type. A minimum load of 60 pounds/LF for wall cabinets shall be supported. Provide a safety factor of 2.
- B. Verify location and sizes of utility rough-in associated with work of this Section.

3.02 INSTALLATION

- A. Install casework, components and accessories in accordance with manufacturer's instructions.
- B. Use anchoring devices to suit conditions and substrate materials encountered. Attach wall mounted cabinets to support framing / blocking / plates, as appropriate, following industry standards and best practices. Ensure that proper fastener type is utilized for support structure material.
- C. Set casework items plumb and square, securely anchored to building structure.
- D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Use filler strips; not additional overlay trim for this purpose.

3.03 ADJUSTING

- A. Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly.

3.04 CLEANING

- A. Clean casework, countertops, shelves, and hardware.

3.05 PROTECTION

- A. Do not permit finished casework to be exposed to continued construction activity.

END OF SECTION

SECTION 12 36 00
COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops for architectural casework.
- B. Countertops for manufactured casework.
- C. Wall-hung counters.
- D. Sinks molded into countertops.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 54 - Wood Blocking and Curbing: Concealed wood blocking.
- B. Section 06 20 00 - Finish Carpentry: Countertop end panels, cleats, support brackets and grommets.
- C. Section 06 41 00 - Architectural Wood Casework.
- D. Section 12 35 30 - Residential Casework.
- E. Division 22 - Plumbing: Sinks.

1.03 REFERENCE STANDARDS

- A. ANSI A161.2 - Performance Standards for Fabricated High Pressure Decorative Laminate Countertops; 1998.
- B. ANSI A208.1 - American National Standard for Particleboard; 2009.
- C. ANSI A208.2 - American National Standard for Medium Density Fiberboard for Interior Use; 2009.
- D. ANSI Z124.3 - American National Standard for Plastic Lavatories; 2005.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- F. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2014.
- G. ISSFA-2 - Classification and Standards for Solid Surfacing Material; 2001 (2007).
- H. ISFA 3-01 - Classification and Standards for Solid Surfacing Material; International Surface Fabricators Association; 2013.
- I. MIA (DSDM) - Dimensional Stone Design Manual; VII, 2007.
- J. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets for surfacing, substrate and other products; include manufacturer's maintenance instructions and recommendations.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
- D. Verification Samples: Submit 4 inches square minimum size samples representing actual products and colors selected.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Same fabricator as for Section 06 41 00 - Architectural Wood Casework.
- B. Installer Qualifications: Fabricator.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOP ASSEMBLIES

- A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS).
- B. Type PL-1, -2, -3, -4, -5, -6, -7, -8, -9, -10,& -11: Plastic Laminate Countertops: High pressure decorative laminate sheet (HPDL) bonded to substrate with backer sheet.
 - 1. Laminate Sheet: HGS, NEMA LD 3 Grade 0.048, nominal 1/16 inch thickness.
 - a. Fire Resistance, ASTM E84: Flame spread 25, max. Smoke developed 450, max.
 - b. NSF approved for food contact.
 - c. Manufacturers and Colors: See Finish Legend.
 - d. Products:
 - 1) Formica Corporation;
 - 2) Nevamar by Panolam Industries International, Inc;
 - 3) Wilsonart International, Inc
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Exposed Edge Treatment: Postformed laminate; front edge substrate built up to minimum 1-1/4 inch thick with raised radiused edge, integral coved backsplash with radiused top edge.
 - 3. Exposed Edge Treatment: Molded plastic (PVC or ABS) edge, 3 mm thickness, 1-5/16 inch wide or as required to completely cover edge of finished panel.
 - a. Color: As selected by Architect from the manufacturer's full line.
 - b. Products:
 - 1) ABS Greenline by Dollken Woodtape.
 - 2) Edge Banding by Charter Industries.
 - 3) Substitutions: See Section 01 60 00 - Product Requirements.
 - 4. Back and End Splashes: Same material, same construction.
 - 5. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.
 - 6. Counter Substrate: See Accessories below.
- C. Type SS-3: Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 1/2 inch.
 - 2. ISSFA-2 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Fire Resistance, ASTM E84: Flame spread 25, max. Smoke developed 450, max.
 - b. NSF approved for food contact.

- c. Sinks and Bowls: Separate units for undercounter mounting; minimum 3/4 inch wall thickness; comply with ANSI Z124.3.
 - 1) # 810 by Corian.
- d. Manufacturers and Colors: See Finish Legend..
- e. Products:
 - 1) Basis of Design: Corian by Dupont
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- 3. Other Components Thickness: 1/2 inch, minimum.
- 4. Exposed Edge Treatment: Built up to 1-1/2 inch thick; bullnosed edge.
- 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high and as indicated on the Drawings.
- 6. Substrate: See Accessories.
- D. Type ST-1: Natural Stone Countertops: Stone slabs bonded to substrate; use as large pieces as possible with inconspicuous adhesive joints.
 - 1. Stone: Granite without cracks, voids, or pin holes; filling with matching epoxy resin is acceptable.
 - 2. Color: See Finish Legend.
 - 3. Stone Thickness: 1-1/2 inch, minimum.
 - 4. Surface Finish: Polished.
 - 5. Exposed Edge Treatment: Square profile stone, 1 inch thick, with 3/16 inch radius corner.
 - 6. Back and End Splashes: Same material, same thickness; for field attachment.
 - 7. Fabricate in accordance with AWI/AWMAC/WI (AWS), Section 11 - Countertops, Premium Grade.
 - 8. Products: The Palette Collection
 - 9. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Type SS-5: Cultured Marble Vanity Tops: Polyester resin composite over substrate.
 - 1. Sheet Thickness: 3/4 inch.
 - 2. Natural Marble, Quartz and Resin Composite Sheets, Slabs and Castings: Complying with ISSFA-2 and NEMA LD-3; polyester resin, mineral filler and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - 3. Surface Burning Characteristics: Flame spread 25, maximum; smoke developed 450, maximum, when tested in accordance with ASTM E84.
 - 4. NSF approved for food contact.
 - 5. Sinks: Integral castings, with at least 3/4 inch wall thickness; complying with ANSI Z124.3.
 - 6. Surface Finish: Polished.
 - 7. Back and End Splashes: Same material, same thickness; integral with vanity top.
 - 8. Color: See Finish Legend.
 - 9. Products: (Basis of Design) Cultured Marble Vanity Top by Rynone.
 - 10. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Type SS-1, -2 & -4: Natural Quartz and Resin Composite Countertops: Homogenous natural quartz and plastic resin surface material over continuous substrate.
 - 1. Flat Sheet Thickness: 1-1/8 inch.
 - 2. Natural Quartz and Resin Composite Sheets, Slabs and Castings: Complying with ISFA 3-01 and NEMA LD 3; orthophthalic polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Factory fabricate components to the greatest extent practical in sizes and shapes indicated; comply with the MIA Dimension Stone Design Manual.
 - b. Surface Burning Characteristics: Flame spread 25, maximum; smoke developed 450, maximum; when tested in accordance with ASTM E84.
 - c. NSF approved for food contact.
 - d. Finish on Exposed Surfaces: Polished.

- e. Edge Treatment:
- f. Splashes: Applied; 4 inches high of same material.
- g. Joint Adhesive: Manufacturer's approved adhesive to create color-matched seam.
- h. Assembled Product Weight: 10 to 15 psf.
- i. Colors and Patterns: See Finish Legend.
- j. Products:
 - 1) Basis of Design: Zodiaq Quartz Surfaces by Dupont.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- 3. Other Components Thickness: 3/4 inch, minimum.
- 4. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

2.02 ACCESSORY MATERIALS

- A. Wood-Based Components:
 - 1. Wood fabricated from old growth timber is not permitted.
- B. Counter Substrate: Particle board; ANSI A208.1 Class M2; no urea formaldehyde-added.
 - 1. Application: Counters with no sinks.
 - 2. Density; 38.7 pcf min.
 - 3. Modulus of Elasticity: 290,100 psi minimum.
 - 4. Panel Thickness for Plastic Laminate Facing: 1-1/8 inches.
 - 5. Panel Thickness for Solid Surfacing: 3/4 inches minimum.
- C. Counter Substrate: Medium density fiberboard; ANSI A208.2; Grade 130; no urea formaldehyde-added; water resistant.
 - 1. Application: Counters with sinks.
 - 2. Density: 45 pcf min.
 - 3. Modulus of Elasticity: 405,000 psi minimum.
 - 4. Panel Thickness for Plastic Laminate Facing: 3/4 inches with built-up edges.
 - 5. Panel Thickness for Solid Surfacing: 3/4 inches minimum.
 - 6. Product: Medex by SierraPine.
- D. Adhesives: Silicone adhesive as recommended by manufacturer of materials being joined.
- E. Joint Sealant: Mildew-resistant silicone sealant, clear.
- F. Wiring Grommets: Plastic, 2" outside diameter; colors selected from manufacturer's full color range.
 - 1. Product: Series TG by Doug Mockett Co., Inc.

2.03 FABRICATION

- A. Fabricate in accordance with standards governing fabrication quality that are specified in herein. Field conditions shall be carefully measured prior to fabrication of countertops.
- B. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using self-leveling metal splines to draw sections together.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- C. Provide back and end splashes wherever counter edge abuts vertical surface unless otherwise indicated. Fabricate splashes 4 inches high, unless otherwise indicated. Splashes shall be fabricated loose, unless indicated to be integral with the counter surface.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches, unless otherwise indicated.
- D. Plastic Laminate Countertops:
 - 1. Fabricate up to 10 feet long without joints. Fabricate up to 5 feet wide without joints.
 - 2. All edges shall be tooled smooth and square.

3. Provide backer surfacing on non-exposed substrate surfaces for balanced construction.
 4. Where materials meet at edges and corners, joints shall butt and overlapping members shall be filed off smooth, forming a slightly eased joint.
 5. All joints shall be shop-prepared. No joint shall be located within 12 inches of a sink or 3 inches of a corner.
- E. Solid Surfacing Countertops:
1. Fabricate tops up to 144 inches long in one piece.
 2. Join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
 3. Provide integral covered backsplashes.
 4. Provide separate square edge side splashes.
 5. Located seams at least 3 inches from corners.
- F. Natural Quartz and Resin Composite Countertops:
1. Fabricate components to greatest extent practical to sizes and shapes indicated, and in accordance with manufacturer's recommendations. Form joints between components using manufacturer's standard joint adhesive and reinforce as required. Provide factory cutouts for plumbing fittings and accessories as required.
 2. Rout and finish component edges with clean, sharp returns. Rout cutouts, radii and contours to template. Smooth edges.
- G. Formed Stone Countertops:
1. Inspect all materials prior to shop fabrication for manufacturing defects.
 2. Locate seams as recommended by the manufacturer.
 3. Minimum radius shall be 3/16". All exposed edges shall be polished.
- H. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on the Drawings, finished to match.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Acclimate countertop materials to temperature and relative humidity of the installation site for at least 24 hours.

3.03 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners and with contact surfaces set in waterproof glue. Verify that cabinet top surfaces are level. Shim where required.
- B. Counter cleats shall be installed at walls where indicated and where required for counter support. See Section 06 20 00 - Finish Carpentry. At countertops with no sinks, if counter cantilevers more than 3 inches beyond cabinet support, install 3/4" plywood over cabinet tops extending to full countertop cantilever. Use moisture resistant MDF at counters with sinks.
- C. Solid Surface Countertops:
 1. Secure countertops to cabinets with silicone sealant. Do not use water based adhesives.
 2. Provide a 1/32 inch expansion for 8 foot length of counter.
 3. Sealant joints shall be 1/8 inch minimum in width.
 4. Seam and finish joints as recommended by the manufacturer.

- D. Formed Stone Countertops:
 - 1. Counters with splashes shall be set 1/8" off wall surface. Set splash in continuous bead of silicone.
 - 2. Cabinet surfaces for support of formed stone, shall be level to 1/16" per 10 feet.
 - 3. Formed stone shall be supported at 24" on center for 2 cm thickness and 36" on center for 3 cm thickness.
 - 4. Seam pieces with manufacturer's color matched adhesive/hardener.
 - 5. Support cantilevered pieces per manufacturer's recommendations.
- E. Natural Quartz and Resin Composite Countertops:
 - 1. Form field joints using manufacture's recommended adhesive, with joint widths not greater than 1/8 inch in finished work. Keep components and hands clean when making joints.
 - 2. Counters with splashes shall be set 1/8" off wall surface. Set splash in continuous bead of silicone.
 - 3. Cabinet surfaces for support of formed stone, shall be level to 1/16" per 10 feet.
 - 4. Formed stone shall be supported at 24" on center for 2 cm thickness and 36" on center for 3 cm thickness.
 - 5. Seam pieces with manufacturer's color matched adhesive/hardener.
 - 6. Support cantilevered pieces per manufacturer's recommendations.
- F. Plastic Laminate Countertops:
 - 1. Attach countertops using screws with minimum penetration into substrate board of 5/8 inch.
 - 2. Finish butt seams with matching sealant, as recommended by manufacturer.
- G. Loose countertop back and side splashes shall be set in a continuous bead of silicone sealant at the countertop and at the wall.
 - 1. Provide a neat continuous bead of silicone at the joint between top of splash and vertical wall surface.

3.04 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

- A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Any scratched or defaced materials shall be completely replaced at no additional cost to the Owner.
- C. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 12 48 13
ENTRANCE FLOOR MATS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet mat.
- B. Substrate patching and leveling.

1.02 RELATED SECTIONS

- A. Section 01 40 00 - Quality Requirements: Concrete substrate moisture testing.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating properties of mat products.
- C. Shop Drawings:
 - 1. Indicate dimensions.
- D. Samples: Submit samples 4 x 4 inches minimum in size, illustrating pattern, color and finish..
- E. Certification and Field Reports:
 - 1. Prior to installation of flooring, submit written certification from the flooring manufacturer that condition of sub-floor is acceptable.
 - 2. Submit copies of manufacturer's technical representative's field reports for each field visit.
- F. Maintenance Materials:
 - 1. See Section 01 60 00 - Product Requirements, and Section 01 78 00 - Project Close-out, for additional provisions.
 - 2. Extra Mat tile material: 5% of each type and color installed.
 - 3. Materials shall be in provided in unbroken packaging when job is complete. Notify the Architect in writing of the quantity and location of materials furnished. These materials may not be used by the Contractor for corrective work during the warranty period.
- G. Maintenance Data: Include cleaning instructions, stain removal procedures.

1.04 FIELD CONDITIONS

- A. See Section 01 00 00 - General Requirements, for minimum indoor air quality improvement requirements.
- B. Store materials for not less than 48 hours prior to installation in area of installation at a relative humidity of between 40 - 67 % and temperature between 65 degrees F to 80 degrees F, to achieve temperature stability. After installed product has cured, thereafter maintain conditions above 55 degrees F.

1.05 WARRANTY

- A. Carpet mats: Provide manufacturer's product warranty against manufacturing defects and faulty workmanship for a period of one (1) year from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 MATS

- A. Walk-off Mat Type EM-1: 100% solution-dyed polypropylene fiber with rubber backing
 - 1. Methenamine Pill Test, ASTM D 2859: Passes.
 - 2. Smoke Density ASTM E662: Pass, less than 450.
 - 3. Radiant Panel, ASTM E648: Class I.
 - 4. Recycled Content: 15% minimum by weight.
 - 5. Roll Width: 13 ft 2 inches

6. Thickness: 7/16 inches
7. Yarn Weight: 73 oz/sq yd.
8. Warranty: 3 year, limited.
9. Color: See Finish Legend.
10. Adhesive: Release-bond adhesive as recommended by the manufacturer.
11. Product: (Basis of Design) Supreme Nop by Mats Inc
12. Substitutions: See 01 60 00 - Product Requirements.

2.02 FABRICATION

- A. Fabricate mats in single unit sizes; fabricate multiple mats where indicated.
- B. Mats shall be fabricated as required to fully extend to adjacent walls, base, sills thresholds etc, leaving no concrete subfloor exposed to view, with as few seams as possible

PART 3 EXECUTION

3.01 EXAMINATION AND FIELD TESTING

- A. Verify that surfaces are flat to tolerances acceptable to mat manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Owner's testing agency shall verify concrete subfloor or self-leveling underlayment surface moisture emission rates and alkalinity in accordance with ASTM F710, prior to installation of any flooring. Test results shall be made available to the contractor for determination of acceptability by the flooring and adhesives manufacturers. Contractor shall obtain instructions from flooring manufacturer if test results are not within their recommendation limits.
- C. Any conditions that could adversely affect the flooring installation shall be corrected, prior to proceeding with the Work. Commencement of the installation of flooring shall be considered acceptance of the concrete slab as being suitable for the intended application. Any conditions that could adversely affect the flooring installation shall be brought to the Contractor's attention, for resolution, prior to proceeding with the Work.

3.02 PREPARATION

- A. Prepare subfloor surfaces as recommended by flooring manufacturer.
- B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor patching compound to achieve smooth, flat, hard surface.
- C. Subfloor surfaces shall not vary more than plus or minus 1/8" in any 10' dimension. Neither shall they vary at a rate greater than 1/16" per running foot. Leveling compound shall be used for larger areas.
- D. Vacuum clean floor recess.

3.03 INSTALLATION

- A. Coordinate the installation of mats with thresholds and transition strips furnished and installed by other trades.
- B. Install walk-off surface after cleaning of finish flooring.
- C. Mats shall completely cover (wall-to-wall) areas so scheduled.
- D. Mat manufacturer's release-bond adhesive shall be applied with a notched towel as recommended by the manufacturer.
- E. Installation area shall remain free of all traffic for a minimum of 24 hours and from wheeled traffic for a minimum of 72 hours, or as otherwise recommended by the flooring manufacturer.

3.04 PROTECTION

- A. Provide protection for all mats until substantial completion.

END OF SECTION

SECTION 14 20 10
PASSENGER ELEVATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Complete elevator systems.
- B. Elevator maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Includes elevator machine foundation.
- B. Section 04 20 00 - Unit Masonry: Masonry hoistway enclosure; building-in and grouting hoistway door frames.
- C. Section 05 12 00 - Structural Steel Framing: Includes hoistway framing.
- D. Section 05 50 00 - Metal Fabrications: Includes pit ladder, sill supports, divider beams, and overhead hoist beams.
- E. Section 07 14 00 - Fluid Applied Waterproofing: Waterproofing of elevator pit walls and floor.
- F. Section 07 72 00 - Roof Accessories: Smoke venting hatch at top of hoistway.
- G. Section 07 81 00 - Applied Fireproofing: Fireproofing of guide rail brackets where attached to building structural members.
- H. Section 08 31 00 - Access Doors and Panels: Fire rated access doors into hoistway.
- I. Section 10 44 00 - Fire Protection Specialties: Fire extinguisher in elevator machine room.
- J. Division 21 - Fire Suppression: Sprinkler heads in hoistway.
- K. Division 22 - Plumbing: Sump pit and oil interceptor.
- L. Division 23 - HVAC: Ventilation and temperature control.
- M. Division 26 - Electrical: Equipment power, shunt trip and wiring; pit lighting.
- N. Division 28 - Electronic Safety and Security: Fire Alarm System
- O. Section 21 13 00 - Fire Suppression Sprinklers: Sprinkler heads in hoistway.
- P. Section 23 34 23 - HVAC Power Ventilators: Mechanical fan for pressurization of elevator hoistway.

1.03 REFERENCE STANDARDS

- A. ASME A17.1 - Safety Code for Elevators and Escalators; The American Society of Mechanical Engineers; 2013.
- B. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010 w/Errata.
- C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.
- F. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.
- G. UL (ECMD) - Electrical Construction Materials Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a meeting three weeks prior to starting work.
 - 1. Review schedule of installation, installation procedures and conditions, and coordination with related work.

- B. Construction Use of Elevator: Not permitted.
- C. ADA Accessibilities Guidelines Maine Barrier Free Design Code.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on the following items:
 - 1. Signal and operating fixtures, operating panels, indicators.
 - 2. Cab design, dimensions, layout, and components.
 - 3. Cab and hoistway door and frame details.
 - 4. Electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate the following information:
 - 1. Locations of Machine Room Equipment: Driving machines, controllers, governors and other components.
 - 2. Hoistway Components: Car, counterweight, sheaves, machine and sheave beams, guide rails, buffers, ropes, and other components.
 - 3. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
 - 4. Individual weight of principal components; load reaction at points of support.
 - 5. Loads on hoisting beams.
 - 6. Clearances and over-travel of car.
 - 7. Location and sizes of access doors, doors, and frames.
 - 8. Expected heat dissipation of elevator equipment in machine room.
 - 9. Applicable seismic design data; certified by a licensed Professional Structural Engineer.
 - 10. Electrical characteristics and connection requirements.
 - 11. Show arrangement of equipment in machine room so rotating elements, sheaves, and other equipment can be removed for repairs or replaced without disturbing other components. Arrange equipment for clear passage through access door.
- D. Powder Coat Paint selection: Submit manufacturer's standard selection charts for exposed finishes and materials.
- E. Plastic Laminate selection: Submit manufacturer's standard selection charts for exposed finishes and materials.
- F. Maintenance Contract.
- G. Maintenance Data: Include:
 - 1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
 - 2. Technical information for servicing operating equipment.
 - 3. Legible schematic of hydraulic piping and wiring diagrams of installed electrical equipment and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.
 - 4. Provide all maintenance data in electronic and hard copy formats.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with applicable code and as supplemented in this section.
- B. Designer Qualifications: Design guide rails, brackets, anchors, and machine anchors under direct supervision of a Professional Structural Engineer experienced in design of work of this type and licensed in the State in which the Project is located.
- C. Fabricate and install door and frame assemblies in accordance with NFPA 80.
- D. Perform electrical work in accordance with NFPA 70.
- E. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

- F. Installer Qualifications: Company specializing in performing the work of this section and approved by elevator equipment manufacturer.
- G. Products Requiring Fire Resistance Rating: Listed and classified by UL.
- H. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 WARRANTY

- A. See Section 01 78 10 - Warranties, for additional warranty requirements.
- B. Provide one year manufacturer warranty for elevator operating equipment and devices starting at date of Substantial Completion of the Project.
- A. Provide emergency 24 hour call back service with services performed during working hours for this maintenance period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer (Basis of Design): ThyssenKrupp Elevator Americas; Product Endura Below-Grade Conventional, 4,000 lb.
- B. Acceptable Manufacturers:
 - 1. Otis Elevator Co:
 - 2. Schindler Elevator Corp:
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- C. All components to be manufactured by same entity, unless otherwise indicated.

2.02 ELEVATORS

- A. Elevator EL-A & EL-B: Passenger, hydraulic with cylinder in buried casing.
 - 1. Car Enclosure: Manufacturer's standard pre-engineered car enclosure including ventilation, lighting, ceiling finish, wall finish, access doors, top of car inspection door, entrance door, trim, accessories.
 - a. Car Wall Finish: Manufacturer's standard high pressure plastic laminate vertical panels complying NEMA LD3, 0.05 inch thickness, color and texture as selected by the Architect from the manufacturer's full range.
 - b. Car Ceiling: Downlight type, metal pans with suspended LED downlights.
 - c. Car Flooring: Shall be provided as a part of the Work of Section 09 65 00. - Resilient Flooring.
 - d. Front Panel and Car Door: AISI Type 302/304 stainless steel with No. 4 satin finish. Car door frame shall be fabricated integrally with the front wall of the car.
 - e. Car Handrails: 1.5" diameter cylindrical satin stainless steel handrails on back and both side walls.
 - f. Protective Pads: One set for each elevator, of full height, heavy cotton duck, padded and quilted, removable with brass grommets and permanent car hooks.
 - g. Elevator certificate holder, matching car front panel finish.
 - 2. Car Top Inspection: Provide a car top inspection station with an "Auto-Inspection" switch, an "emergency stop" switch and constant pressure "up and down" direction and safety buttons to make the normal operating devices inoperative. The station will give the inspector complete control of the elevator. The car top inspection station shall be mounted in the door operator assembly.
 - 3. Hoistway Doors and Frames: Baked enamel on steel.
 - 4. Cab Height: 96 inches, nominal.
 - 5. Hoistway and Cab Entrance Frame Opening Size: 3'-6" x 7'-0".
 - 6. Door Type: Single leaf.
 - 7. Door Operation: Center opening.
 - 8. Rated Net Capacity: 4,000 lbs.

9. Rated Speed: 150 ft/min.
10. Seismic Requirements; Zone 2.
11. Travel Distance: As indicated on drawings.
12. Number of Stops: 6.
13. Number of Openings: 6 Front.
14. Pit ladder, primed steel, in conformance to OSHA standards and ASME A17 requirements.
15. Hydraulic Motor and Pump Location: Adjacent to hoistway.

2.03 CONTROLS

- A. Elevator Controls: Provide landing buttons and hall lanterns.
 1. Fixture and Button Style: Signa4 Signal Fixtures
- B. Door Controls:
 1. Program door control to open doors automatically when car arrives at floor.
 2. Render "Door Close" button inoperative when car is standing at dispatching terminal with doors open.
 3. If doors are prevented from closing for approximately ten seconds because of an obstruction, automatically disconnect door reopening devices, close doors more slowly until obstruction is cleared. Sound buzzer.
 4. Door Safety Devices: Moveable, retractable safety edges, quiet in operation; equip with object proximity detector device.
- C. Landing Buttons: Stainless steel type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows.
- D. Interconnect elevator control system with building fire alarm systems.
 1. Elevator EL-B: Designated Accessible Means of Egress. Provide compliance with Section 2.27 of ASME A17.1 and other applicable regulations.
- E. Emergency Communication System: Integral phone system provided.
- F. Provide "Firefighter's Operation" in accordance with applicable code. Designated Landing: Ground Level.
- G. Telephone: Car telephone with vandal resistant auto dial and visual signal that call has been answered, Braille / raised lettering, ADA compliant, complete with identification and instructions for use. Locate in return panel adjacent to car door, finish to be satin stainless steel. Connection from the elevator machine room to the building telephone system shall be provided by others.
- H. Signage: Comply with all applicable codes and ADA Architectural Guidelines. Provide raised markings, for all controls, hall buttons and signals. Hall button signage shall include directional graphics. Provide door jamb markings, numbers and Braille. Provide capacity sign engraved into front inside of each car. Provide "In case of fire.." engraved signage adjacent to hall buttons including pictorial of person descending stairs during a fire. All signage shall be on contrasting background.

2.04 EMERGENCY POWER

- A. Elevator "EL-B": Arrange elevator operation to operate under emergency power when normal power supply fails.
 1. Emergency Power Supply: Building emergency power; provide for emergency power characteristics and phase rotation same as for normal power. Provide transfer switches and auxiliary contacts in accordance with Division 26 Electrical. Install connections to power feeders.
 2. Provide operational control circuitry for adapting the change from normal to emergency power.
 3. Upon transfer to emergency power, advance elevator to a pre-selected landing, stop car, open doors, disable operating circuits, and hold in standby condition.

4. After the above operation has completed one complete cycle, operate one pre-selected elevator in normal operation from the emergency power supply. If the pre-selected car fails to operate, automatically select another car to operate.
 5. Provide manual switch to override the automatic selection procedure.
- B. Elevator "EL-A": Emergency Power Supply: Self-contained battery power.
1. Upon transfer to emergency power, advance elevator to a pre-selected landing, stop car, open doors, disable operating circuits, and hold in standby condition.

2.05 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics:
1. 208 volts, three phase, 60 Hz.

2.06 MACHINE ROOM FITTINGS

- A. Wall-Mounted Frames: Glazed with clear plastic; sized as required. Provide one for master electric and hydraulic schematic and one for lubrication chart. Install charts.
1. Provide frame for original copy of the elevator licensing certificate.
- B. Fire Extinguisher: See Section 10 44 00 - Fire Protection Specialties.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that hoistway, pit, and machine room are ready for work of this section.
- C. Verify hoistway shaft and openings are of correct size and within tolerance.
- D. Verify location and size of machine foundation and position of machine foundation bolts.
- E. Verify that electrical power is available and of the correct characteristics.

3.02 PREPARATION

- A. Arrange for temporary electrical power for installation work and testing of elevator components.

3.03 INSTALLATION

- A. Install system components. Connect equipment to building utilities.
- B. Provide conduit, boxes, wiring, and accessories.
- C. Mount machines on vibration and acoustic isolators, on bed plate and concrete pad. Place on structural supports and bearing plates. Securely fasten to building supports. Prevent lateral displacement.
- D. Accommodate equipment in space indicated.
- E. Install guide rails using threaded bolts with metal shims and lock washers under nuts. Compensate for expansion and contraction movement of guide rails.
- F. Accurately machine and align guide rails. Form smooth joints with machined splice plates.
- G. Bolt brackets to inserts placed in concrete form work that will perform to four times the rated pull-out load.
- H. Coordinate installation of hoistway wall construction.
- I. Install hoistway door sills, frames, and headers in hoistway walls. Grout sills in place. Set entrances in vertical alignment with car openings and aligned with plumb hoistway lines.
- J. Fill hoistway door frames solid with grout in accordance with Section 04 20 00.
- K. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime two coats.
- L. Machine Room Components: Clean and degrease; prime one coat, finish with one coat of enamel.

- M. Adjust equipment for smooth and quiet operation.

3.04 ERECTION TOLERANCES

- A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1.
- B. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.05 FIELD QUALITY CONTROL

- A. Testing and inspection by regulatory agencies will be performed at their discretion.
 - 1. Schedule tests with agencies and notify Owner and Architect.
 - 2. Obtain permits required to perform tests.
 - 3. Document regulatory agency tests and inspections in accordance with the requirements of Section 01 40 00.
 - 4. Perform tests required by regulatory agencies.
 - 5. Furnish test and approval certificates issued by Authorities Having Jurisdiction.
- B. Instruction and Demonstration: Instruct Owner's personnel in proper use and operation of the elevators. Review emergency provisions, including emergency access and procedures for an operating failure or other building emergency. Train Owner's personnel in normal procedures to be followed in checking for sources of operational failures or malfunctions. Review the 12-month maintenance program provided as part of the scope of this Work.

3.06 ADJUSTING

- A. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.
- B. Adjust automatic floor leveling feature at each floor to achieve 1/4 inch from flush.

3.07 CLEANING

- A. Remove protective coverings from finished surfaces.
- B. Clean surfaces and components ready for inspection.

3.08 PROTECTION

- A. Do not permit construction traffic within cab after cleaning.
- B. Protect installed products until project completion.
- C. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

3.09 MAINTENANCE

- A. See Section 01 78 00 - Project Close-out, for additional requirements.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer or original installer. Notify Owner prior to all maintenance and provide follow-up documentation to the Owner after each visit.
- D. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of Owner.
- E. Provide service and maintenance of elevator system and components for one year from Date of Substantial Completion of the Project.
- F. Examine system components monthly. Clean, adjust, and lubricate equipment. Provide a maintenance visit at the end of the twelve month period.
- G. Maintenance shall be in accordance with recommendations and requirements of ASME A17.1.
- H. Include systematic examination, adjustment, and lubrication of elevator equipment. Maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.
- I. Perform work without removing cars during peak traffic periods.

- J. Provide emergency call back service during working hours for this maintenance period.

END OF SECTION

SECTION 14 91 00
FACILITY CHUTES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Gravity chutes for waste (trash, refuse).
- B. Chute maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 07 54 00 - Thermoplastic Membrane Roofing: Cants and roofing flashing at chute roof vents.
- B. Section 07 62 00 - Sheet Metal Flashing and Trim: Counterflashing at chute roof vent.
- C. Section 28 31 00 - Fire Detection and Alarm: Connection of interlock systems and sensors to fire alarm system.
- D. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Connection to sprinklers inside chute.
- E. Section 22 10 05 - Plumbing Piping:
 - 1. Water piping connections to spray cleaning equipment.
- F. Section 26 27 17 - Equipment Wiring:
 - 1. Connection of control panels to 110 VAC electrical power.
 - 2. Wiring and conduit between control panels and controlled components.
 - 3. Wiring and conduit between discharge room spray cleaning switch and flushing spray head.

1.03 REFERENCE STANDARDS

- A. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2013.
- B. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment; National Fire Protection Association; 2014.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene 7 days before start of installation to review code requirements, manufacturer's recommendations, and related work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for additional requirements.
- B. Product Data: Manufacturer's printed data sheets on each component, indicating which options are provided.
- C. Shop Drawings: Detailed layout of chute and components, indicating interface with structure, enclosing walls, and utilities; show:
 - 1. Openings in floors and required clearances.
 - 2. Location and size of each field connection to structure.
 - 3. Pipe sizes and locations.
 - 4. Electrical wiring sizes, conduits, and location of connections.
 - 5. Clearly indicate components required but not furnished by chute installer.
- D. Reports: Submit for each test/inspection; see Section 01 40 00 for requirements.
- E. Certificates: Certify that chute assembly meets or exceeds NFPA 82 and specified requirements.
- F. Maintenance Contract.
- G. Operation and Maintenance Data: Manufacturer's operation instructions.
 - 1. Include control wiring diagrams.

1.06 QUALITY ASSURANCE

- A. See Section 01 40 00 for additional requirements.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.
- C. Manufacturer Qualifications: Company specializing in making products specified in this section.
 - 1. With not less than three years of experience.
 - 2. With similar installation in satisfactory service for at least one year.
- D. Installer Qualifications: Company specializing in performing the work of this section:
 - 1. With minimum 2 years of documented experience.

1.07 WARRANTY

- A. See Section 01 78 00 for additional requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Chutes and Chute Components: Use one of the following:
 - 1. Basis of Design; CHUTES International; Trash Chutes:
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All components need not be made by the same manufacturer, provided manufacturer providing assembled units assumes responsibility for all components.

2.02 CHUTES

- A. Waste Chutes: Sheet metal, round, constant diameter extending from above roof to lowest floor, with intake doors at each floor and bottom outlet into room designated on drawings; complying with requirements of NFPA 82 and local code.
 - 1. Diameter: 24 inches inside.
 - 2. Intake Doors: Hopper type, no locks.
 - 3. Intake Door Size: 15 by 18 inches wide by high.
 - 4. Intake Door Operator: ADA-compliant pneumatic operator that unlatches and opens door.
 - 5. Interlock system and sensors that automatically prevent:
 - a. Opening more than one intake door at a time.
 - b. Opening any intake door when temperature in chute exceeds predetermined, adjustable temperature.
 - c. Opening any intake door when spray cleaning is in progress.

2.03 COMPONENTS

- A. Chute: Factory-fabricated to the greatest extent possible, with continuously welded or lock-seamed joints and smooth, non-slag interior (no protruding bolts, rivets, hardware, sharp edges or corners).
 - 1. Material: Stainless steel sheet.
 - 2. Sheet Metal Thickness: 16 gage, 0.06 inch.
 - 3. Throat Sections: Provide sloped throat sections for intake doors, of same material and construction as chute.
 - 4. Factory-coat outside of chute with sprayed sound-dampening material.
 - 5. Fabricate with support frames at each floor with sound isolator pads and expansion joints in chute between each support point.
- B. Intake Doors: Factory-assembled door and frame, self-closing and positive-latching; frame designed for chase construction, flush-mounted.
 - 1. Material: Stainless steel, brushed or satin finish.
 - 2. Fire Rating: 1-1/2 hour ("B" label) with 30-minute temperature rise of 250 degrees F.
 - 3. Pulls: T-handle or lever handle latch; polished stainless steel.

4. Signs: Mark on frame or door face the purpose of the chute, using engraving, integral raised lettering, or other permanent signs.
- C. Discharge Doors: Aluminum-coated steel; normally-open, 1 1/2-hour ("B" label) fire rated, with fusible link closing; style as required by chute configuration.
 1. Vertical Discharge Style: Inclined horizontally rolling shutter, closing by gravity.
- D. Access Doors: Same construction and fire rating as intake doors, with locks; provide wherever equipment requiring maintenance is located inside chute, including sprinklers and plumbing and electrical connections.
- E. Roof Vent: Full diameter, extending minimum 48 inches above roof level, with roof deck flange.
 1. Material: Manufacturer's standard.
 2. Counterflashing and clamping ring of non-ferrous metal compatible with chute material.
 3. Top Unit: Screened vent.
- F. Fire Sprinklers: Comply with NFPA 82 and NFPA 13; provide 1/2 inch NPS sprinkler heads mounted inside chute intake throats at the following locations:
 1. At or above the top intake opening.
 2. At the lowest intake opening.
 3. In buildings of more than two stories, at every other floor.
- G. Spray Cleaning Equipment:
 1. Flushing Spray: Solenoid controlled 3/4 inch NPS spray head mounted above top intake door.
 2. Sanitizing Unit: Tank and feeder to introduce disinfectant into flushing spray line.
 - a. Provide backflow preventer valve and actuator switch.
 - b. Minimum 1 gallon capacity.
 - c. Accessible through access door immediately above top intake door.
- H. Electrical Controls: 110 V AC.
- I. Pneumatic Operators: Compressed air units; provide compressor, air tubing, and control panel.
- J. Nameplates: Identify the manufacturer in conspicuous location on chute doors and equipment, using permanent nameplate, casting, or stamping.

PART 3 EXECUTION

3.01 COORDINATION

- A. Complete chute installation and testing before completion of enclosing construction.
- B. Coordinate sprinkler and spray cleaning devices with size, location and installation of service utilities.
- C. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

3.02 INSTALLATION

- A. Install chutes and equipment in accordance with NFPA 82 requirements and manufacturer's instructions.
- B. Maintain fire-resistive capacity of enclosing walls.
- C. Install chute plumb and without offsets or obstructions that might prevent free fall of materials, except where indicated on drawings.
- D. Anchor securely in manner required to withstand impact and weight of materials in chute.
- E. Install roof vent flange to roof deck prior to installation of roofing.
- F. Install counterflashing after roofing installation.
- G. Adjust doors and other operating components for smooth operation.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 for additional requirements.
- B. Place bagged material of expected size in chute to verify free fall.
- C. Test all components for proper operation.
 - 1. Operate doors, locks, and interlocks.
 - 2. Operate spray cleaning devices.
 - 3. Simulate fire conditions inside chute to verify sprinkler and detector operation.

3.04 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of chute and equipment for one year from Date of Substantial Completion.

END OF SECTION

SECTION 21 10 00 - FIRE-SUPPRESSION SPRINKLER 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 fire-suppression sprinklers, piping, and equipment.
- B. The Sprinkler Contractor shall place the sprinkler system in service and hand over the sprinkler system to the General Contractor for care and maintenance.
- C. Performance and Design Criteria: Provide products and systems complying with specific performance and design criteria indicated.
- D. Existing Building: The existing building is served by a combined 6" sprinkler/standpipe system and a 50HP fire pump. The existing fire pump will be replaced by a new diesel-driven fire pump located in Fire Pump Room G007. The existing sprinkler and standpipe system will remain in place for phased tie-in to the new fire pump. Revise piping and sprinkler heads to suit the renovations in the existing building
 - 1. Existing static pressure is approximately 50 psi (pressure gauge observation 9/5/14) at the first floor mechanical room. The water data on file with the State permit indicates 56 psi static, 48 psi residual, with 1,342 GPM flowing (7/20/94).
 - 2. Refer to Sheet A0.2A for existing and proposed building areas and heights.
- E. New Building: Provide a complete new diesel driven fire pump to serve the entire building (new and existing) as follows: Provide a separate combination sprinkler and standpipe riser with trim to serve the existing system, provide a combined sprinkler/standpipe riser with trim to serve the addition and a dry sprinkler riser with trim to serve the garage. Connect a new 4" pipe to a new fire department connection as shown on drawings.
 - 1. Provide a complete, tested and operational NFPA 13 fire protection system. A Maine licensed fire protection contractor shall fully design the facility fire protection systems based on the codes, standards, and authority with jurisdiction.
 - 2. Obtain all permits and gain approvals from Authorities Having Jurisdiction for designs and installations.
 - 3. Fire protection system will be a wet system for all areas of the building except the parking garage. The parking garage will be protected by a dry sprinkler system.
 - 4. Class I automatic-wet standpipes shall be provided in each new egress stairwell, as per NFPA 14.
 - 5. Fire Protection installations shall be seismically braced per IBC 2009, NFPA 13, and NFPA 14.

6. Water supply will be municipal. Contact Allied Engineering or Portland Water District for current fire flow results.
 7. Provide a diesel fire pump system per NFPA 25.
 8. Provide service entrance per PWD requirements. System shall be protected from backflow by the installation of a double-check valve assembly at the service entrance and before the fire sprinkler valve.
 9. Provide design and components as necessary to meet NFPA 13 and local codes.
- F. Preliminary sprinkler system layouts are shown on the plumbing drawings. The sprinkler contractor is responsible for final/actual system design, sizing, and layout.
- G. The floor to floor spacing is tight, with limited space for piping. Holes in beams are indicated on the structural plans.
- 1.3 PORTLAND FIRE DEPARTMENT - WATER-BASED FIRE SUPPRESSION SYSTEM PERMIT APPLICATION CHECKLIST

- A. The sprinkler contractor shall validate and provide all items.
- B. General
1. Vectored PDF plans and documents included (same as submitted to the State Fire Marshal where applicable).
 2. Sprinkler installation costs: Contractor provide.
 3. State Sprinkler license number: Contractor provide.
 4. State Sprinkler Permit / log number: Contractor provide.
 5. Life Safety Code Occupancy Classification:
 6. Is this new work or a renovation to an existing system? Renovation
 7. Will the system be a combination sprinkler and standpipe system? Yes
 8. The water supply is: Municipal
 9. A copy of the state sprinkler permit with RMS sign off is required prior to the final inspection
 10. Design complies with City Code Ch. 10 and Fire Department Regulations Ch 6.
- C. NFPA-13 Checklist
1. What edition of NFPA 13 is the designed to?: 2007
 2. Building construction type: SEE SHEET A0.2A.
 3. Will the sprinkler system provide complete or partial coverage of the building?
COMPLETE
 4. System type (See NFPA 13:3.4): WET PIPE SPRINKLER SYSTEM
 5. NFPA 13 Occupancy Classification (Hazard):
 - a. LIGHT HAZARD:
 - 1) OFFICE AND PUBLIC AREAS
 - 2) RESIDENTIAL

b. ORDINARY HAZARD, GROUP 1:

- 1) GENERAL STORAGE AREAS
 - 2) MECHANICAL EQUIPMENT ROOMS
 - 3) BUILDING SERVICE AREAS.
 - 4) ELECTRICAL EQUIPMENT ROOMS
6. Is the structure high-rise (see NFPA 101:3.3.32.7)? NO
 7. Size of riser assembly: 6" – CONTRACTOR CONFIRM.
 8. Fire department connection- number of 2 ½" inlets: STORZ PER PFD REQUIREMENTS; SEE PLANS FOR LOCATION.
 9. Electrical supervision will be provided via the fire alarm system per NFPA 101:9.7.2: YES
 10. Is the nearest fire hydrant within 100 ft. of the FDC? YES
 11. The completed Contractor's Material and Test Certificate for Aboveground Piping shall be provided at the completion of the job? CONTRACTOR PROVIDE.

D. NFPA 14 standpipe check list

1. What edition of NFPA 14 is the designed to? 2007
2. What class of standpipe is this? CLASS I
3. Is the system automatic or manual? AUTOMATIC
4. Is the system wet or dry (see NFPA 14:5.4.1.4)? Wet
5. Is the structure high-rise (see NFPA 101:3.3.32.7)? NO
6. What is the minimum residual pressure for the most remote hose connection (see NFPA 14:7.8.1 and 7.8.2)?
7. What is the maximum static pressure at hose connections (see NFPA 14:7.8.3)?
8. Are floor control valve assemblies provided (see NFPA 14:6.3.5)?
9. Number of standpipes (see NFPA 14:3.3.11):
10. Minimum required flow rate (see NFPA 14:7.10):
11. Fire department connection- number of 2 ½" inlets (see NFPA 14:7.12.3):
12. What is the pressure required at the FDC inlets to deliver the system demand (see NFPA 14:6.4.5.2.2):
13. Is the nearest fire hydrant within 100 ft. of the FDC (see NFPA 14:6.4.5.4)? YES
14. The completed Standpipe Contractor's Material and Test Certificate for Aboveground Piping and Undergrounding Piping as applicable shall be provided at the completion of the job (see NFPA 14:11.1.3): YES

E. NFPA 20 fire pump check list

1. What edition of NFPA 20 is the designed to? 2007
2. What is the water source? MUNICIPAL
3. Is the pump and associated equipment listed for fire service? YES
4. What is the minimum required flow rate? CONTRACTOR CONFIRM.
5. What is the pump driver type? DIESEL
6. Is the pump design less than 7 HP? NO
7. If less than 7 HP does the pump have a general listing and has its use been approved by the State Fire Marshal's Office? N/A
8. Will the equipment be protected in accordance with NFPA 14:5.12? YES
9. Is the pump installed at least 50 ft. from the protected premises? NO
10. If not what is the fire resistance separation provided (see NFPA 14:5.12.1.1)? 2 HOUR

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Design sprinklers and obtain approval from authorities having jurisdiction. The design of the automatic sprinkler system shall be complete with all necessary accessories for proper operation.
- B. In the contract documents, general layout, specifications, and components are indicated. Contractor is required to provide components and coordination as required for a complete, code compliant systems. Required items for code-compliance supersede these specifications.
- C. The system shall be hydraulically calculated in accordance with all provisions of the Contract Documents and any authority having jurisdiction.
- D. Reuse of existing piping shall be allowed if proven to meet the demands based upon hydraulic calculations. Sprinkler piping design shall be according to the following and obtain approval from authorities having jurisdiction:
 - 1. Include a 5 percent margin of safety for available water flow and pressure.
 - 2. Include losses through water-service piping, valves, and backflow preventers.
- E. Minimum Density for Automatic-Sprinkler Piping Design shall be in accordance with NFPA 13. Maximum Protection Area per Sprinkler shall be in accordance with NFPA 13.
- F. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.

1.5 GENERAL REQUIREMENTS

- A. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.
- B. Protect all systems from freezing. Provide freeze protection for sprinklers in unheated areas with a dry pipe system.
- C. Bundled/Grouped wired in concealed spaces: Non-combustible spaces having 15 or more non-plenum-rated wires grouped together shall be fully sprinklered.
- D. Seismic Performance: If required by the authority with jurisdiction, fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.
- E. Elevators (2) & Trash Chutes (2): Provide sprinkler protection in accordance with NFPA-82 and authority with jurisdiction requirements.
- F. Contractor shall obtain and pay for required permits.

1.6 SUBMITTALS

- A. Shop Drawings: Submit working plans, prepared according to NFPA 13, and hydraulic calculations with cross reference to applicable drawings, water supply data, and equipment

schedule with ratings for the system to the Owner's Representative, Insurance Underwriter, and other authorities having jurisdiction.

- B. Product Data: Catalog sheets, specifications, and installation instructions. Indicate UL or FM approval for each product. Include the following additional information:
1. Pipe and fitting materials and methods of joining for sprinkler piping.
 2. Pipe hangers and supports.
 3. Piping seismic restraints.
 4. Valves, including specialty valves, accessories, and devices.
 5. Alarm devices. Include electrical data.
 6. Electrical Devices: Complete description of intended use, wiring diagrams, data plate information and, in the case of switching devices, whether normally on or normally off. Include motor test data.
 7. Mechanical Devices: Complete description of intended use, including normal operating capacities and working pressures.
 8. Enclosures: Dimensions, materials, gages of metals; type of door hinges and locks, and methods of securing the enclosure members to the building construction.
 9. Hose Threads: Verify that hose threads on fire department connections match threads on equipment used by the local or servicing fire department.
 10. For fire-suppression standpipes. Include plans, elevations, sections, details, and attachments to other work.
- C. Design Data: The portions of the sprinkler system not sized on the Contract Drawings shall be sized in accordance with NFPA requirements for Hydraulically Designed Systems. Submit drawings and hydraulic calculations for approval.
- D. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible sprinkler system design professional. Indicate that products and systems comply with performance and design criteria in the Contract Documents.
1. Certification: Submit Contractor's NICET certification and number or PE license number.
- E. 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" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Maintenance Data: For each type of sprinkler specialty to include in maintenance manuals specified in Division 1.

1.7 QUALITY ASSURANCE

A. Sprinkler Contractor

1. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.

2. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified sprinkler designer. Base calculations on results of fire hydrant flow test. Sprinkler designer shall be legally qualified and licensed to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.
3. Contractor shall be a licensed fire sprinkler contractor.

B. Manufacturer Qualifications:

1. Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.
2. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
4. Factory Mutual Engineering Corporation (FM) Approval Guide

C. NFPA Requirements:

1. NFPA#1 Fire Prevention Code
2. NFPA #13 "Standard for the Installation of Sprinkler Systems"
3. NFPA #14 Standard for the Installation of Standpipe, Private Hydrants and Hose Systems
4. NFPA 20, "Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and their installation.
5. NFPA #24 Standard for the Installation of Private Fire Service Mains and Their Appurtenances
6. NFPA 291: Recommend Practice for Flow Testing and Marking of Hydrants

1.8 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.9 EXTRA MATERIALS

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

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

PART 2 - PRODUCTS

2.1 PIPING

- A. Pipe and fittings shall conform to the requirements of NFPA 13. Pipe shall be listed by UL and be FM approved, and installed per its listing and approval.
- B. System piping shall be substantially supported to the building structure. The installation of hangers and supports shall adhere to the requirements set forth in N.F.P.A. 13. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application.

2.2 JOINING MATERIALS

- A. Furnish in accordance with NFPA 13.
- B. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.3 SPRINKLERS

- A. Fire sprinklers shall be of one manufacturer throughout the building. No mixing of sprinkler brands shall be permitted. Sprinklers shall be of all brass frame construction with a quick response frangible bulb type fusible element.
- B. Automatic Sprinklers: With heat-responsive element complying with the following:
 - 1. UL 199, for applications except residential.
 - 2. UL 1767, for early suppression, fast-response applications.
- C. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- D. Provide quick response sprinklers.
- E. Install new sprinkler heads throughout spaces where new ceilings are installed. Existing sprinkler heads shall not be reinstalled.
- F. Match type and classification of surrounding existing sprinklers in remodeled space where existing ceilings remain and the use group has not changed.
- G. Sprinkler Escutcheons: Materials, types, and finishes of sprinklers. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
- H. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.4 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
- B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
- C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
- D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
- E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
- F. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.5 VALVES

- A. Valves shall be UL listed and FMG approved
- B. System Control Valve: The wet system control valve shall be a listed indicating type valve. Control valve shall be UL Listed and Factory Mutual Approved for fire protection installations. System control valve shall be rated for normal system pressure but in no case less than 175 PSI.

2.6 WATERFLOW ALARMS

- A. Flow of water equal to or greater than that from a single automatic sprinkler (smallest orifice in system) shall result in an audible alarm on the premises within 5 minutes after such flow begins and until such flow stops.
- B. The alarm apparatus shall consist of a listed alarm check valve or other listed waterflow-indicating device with the necessary attachments to give an alarm.
- C. The apparatus for a dry pipe system shall consist of alarm attachments to the dry pipe valve.

2.7 FIRE DEPARTMENT CONNECTION

- A. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, polished brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "COMBINED AUTO SPKR."

2.8 STANDPIPE HOSE CONNECTIONS

A. Adjustable-Valve Hose Connections:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Elkhart Brass Mfg. Company, Inc.
 - c. Fire-End & Croker Corporation.
 - d. Fire Protection Products, Inc.
 - e. GMR International Equipment Corporation.
 - f. Guardian Fire Equipment, Inc.
 - g. Potter Roemer.
 - h. Tyco Fire & Building Products LP.
 - i. Wilson & Cousins Inc.
 - j. Zurn Plumbing Products Group; Wilkins Water Control Products Division.
2. Standard: UL 668 hose valve, with integral UL 1468 reducing or restricting pressure-control device, for connecting fire hose.
3. Pressure Rating: 300 psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2, as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle or gate.
9. Pressure-Control Device Type: Per NFPA 20 requirements.
10. Design Outlet Pressure Setting: Per NFPA 20 requirements and City of Portland

2.9 BACKFLOW PREVENTION

- A. Provide in accordance with manufacturers recommendations.
- B. Provide in accordance with NFPA 13. Provide a permanent means of testing the backflow preventer in accordance with NFPA 13 requirements.
- C. Double check: Watts Series 709DCDA or 774DCDA detector check fire service applications; or approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 for excavating, trenching, and backfilling.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 31 Section "Water Distribution" for exterior piping.
- B. Install shutoff valve, pressure gage, drain, and other NFPA-required accessories at connection to water-service piping.
- C. Provide backflow prevention as required by the local water district.

3.3 PREPARATION

- A. The nature of the work requires coordination with other trades. Shop fabrication shall be done at the Contractor's risk. Relocation of piping and components to avoid obstructions may be necessary. Relocation, if required, shall be done at the Contractor's expense. The installation shall be performed in a workmanlike manner as determined by the Owner's Representative and in accordance with the Contract Documents, manufacturer's printed installation instructions, and submitted and Owner's Representative reviewed drawings.
- B. Existing Sprinkler System Shutdown:
 - 1. Follow NFPA, NFPA 25, and NFPA 101 recommendations.
 - 2. Where a required automatic sprinkler system is out of service for more than 4 hours in a 24-hour period, the authority having jurisdiction shall be notified, and the building shall be evacuated or an approved fire watch shall be provided for all parties left unprotected by the shutdown until the sprinkler system has been returned to service.
 - 3. Before shutting down the sprinkler system to perform the Work, notify the Owner's Representative in writing 48 hours in advance, and the local fire department that the system is to be shut down temporarily. Give schedule which states date and time of proposed shut down and the approximate length of time that the system will be out of service. Request instructions for precautions that should be taken during the shutdown period.
 - 4. Do not shut down the system until schedule is approved by the Owner's Representative.
 - 5. Return the existing system to pre-shutdown operation immediately after the Work has been completed. Give written notice to the Director's Representative that the system has been returned to pre-shutdown operation.

3.4 SPRINKLER APPLICATIONS

- A. General: Use sprinklers according to the following applications:
 - 1. Rooms/spaces without Ceilings: Upright sprinklers.
 - 2. All occupied rooms with Finished Ceilings: Recessed Pendent.
 - 3. Provide sprinkler guards for heads in mechanical and storage spaces, less than 8 ft. above finished floor subject to mechanical damage.

4. Low ceilings (under 8 feet): Concealed
5. Corridor ceilings: Concealed
6. Wall Mounting: Sidewall sprinklers.
7. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
8. Special Applications: Use extended-coverage, flow-control, and quick-response sprinklers where indicated.

B. Finishes

- a. Unfinished spaces not exposed to view: rough bronze.
- b. Recessed Sprinklers: White
- c. Provide escutcheons with matching color for finished spaces.
- d. Exposed sprinklers subject to corrosive atmospheres shall have a factory applied corrosion resistant coating.

3.5 SYSTEM INSTALLATIONS

- A. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- B. Water supply control valves shall be electrically supervised and mechanically locked for proper position. Water flow and supervisory circuits shall be in accordance with the requirements of electrical specifications. Electric connections to sprinkler system shall be by Division 26. Furnish wiring diagrams for all equipment.
- C. Fire Department Connection: A system fire department connection shall be provided on the system riser in accordance with N.F.P.A. 13. Fire department connection shall be installed in an area accessible for the first response unit. Coordinate with local fire department.
- D. A sprinkler head wrench of each style and model installed shall be provided to the owner at the completion of the project. A representative sampling of each sprinkler head style and model shall be provided to the owner and housed in a sprinkler head cabinet at or near the sprinkler riser. The number of sprinkler heads provided to the owner shall be in accordance with NFPA 13.
- E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13
- F. Piping Standard: Comply with requirements in NFPA.
- G. Install drain valves on standpipes. Extend drain piping to outside of building.
- H. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.
- I. Install alarm devices in piping systems.

- J. Install pressure gages on riser or feed main and at top of each standpipe. 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.
- K. Fill wet-type standpipe system piping with water.
- L. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and 14.

3.6 HOSE-CONNECTION INSTALLATION

- A. Install hose connections adjacent to standpipes.
- B. Standpipe risers may be exposed in stairwells.

3.7 SPRINKLER INSTALLATION

- A. Provide sprinklers in suspended ceiling in center of all ceiling tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space per NFPA 13.
- C. Provide sprinkler piping with drains for complete system drainage.
- D. Hangers and Supports: Comply with NFPA 13 for hanger materials.

3.8 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.9 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
- C. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- D. Verify that specified tests of piping are complete.
- E. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

- F. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- G. Verify that potable-water supplies have correct types of backflow preventers.
- H. Verify that fire department connections have same type compatible with local fire department equipment.
- I. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- J. Fill wet-pipe sprinkler piping with water.
- K. Energize circuits to electrical equipment and devices.
- L. Coordinate with fire alarm tests. Operate as required.

3.10 CLEANING

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

3.11 PAINTING

- A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.12 PROTECTION

- A. Protect sprinklers from damage until Substantial Completion.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

END OF SECTION 21 00 00

SECTION 21 31 16 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire pumps.
 - 2. Fire-pump accessories and specialties.
 - 3. Flowmeter systems.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fire pumps, engine drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each fire pump, from manufacturer.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

1.7 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 20, "Installation of Stationary Pumps for Fire Protection."

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.

- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.2 MULTISTAGE, SPLIT-CASE FIRE PUMPS

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

1. A-C Fire Pump Systems; a business of ITT Industries.
2. Patterson Pump Company; a subsidiary of the Gorman-Rupp Company.
3. Pentair Pump Group; Aurora Pump.

- B. Pump:

1. Standard: UL 448, for split-case pumps for fire service, diesel-driven.
2. Pump shall be UL listed / FM approved with common base and steel grid coupling.
3. Number Stages: Two.
4. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
5. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
6. Wear Rings: Replaceable bronze.
7. Shaft and Sleeve: Steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
8. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

- C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

- D. Driver:

1. Standard: UL 1247.
2. Type: Diesel engine; Clarke model JU4H-UFADJ8 Tier 3 UL listed and FM approved diesel engine.
3. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
4. Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
 - a. Piping: ASTM B 88, Type L, copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
5. Engine-Jacket Water Heater: Factory-installed electric elements.
6. Dual Batteries: Lead-acid 12-volt storage type with 100 percent standby reserve capacity; complete with racks and cables.

7. Fuel System:
 - a. Comply with NFPA 20.
 - b. Comply with NFPA 31.
 - c. Comply with the Maine Fuel Board Laws and Rules. A master oil and solid fuel burning technician shall be in charge of the installation and shall be responsible for ascertaining total conformance to the standards and rules adopted by the board.
 - d. Fuel Storage Tank: 180 gallon or not less than required by NFPA 20. Include floor legs, direct-reading level gage, and double-wall secondary containment tank with capacity at least equal to fuel storage tank. Provide a reinforced concrete pad.
 - e. Provide fittings, piping, and trim per NFPA 20.
 - f. Provide a wall-mounted remote fill alarm, outdoors adjacent to the diesel fill.
 - g. Provide a vent whistle over fill device.
 - h. A listed lever or wheel, thermally-operated oil shut-off valve designed to shut off the oil supply in case of fire, shall be installed at the burner and at the oil supply tank.
 - i. Provide leak detection and monitoring, wired and alarmed to the Building Automation System; coordinate with Section 230993.
 - j. Fuel piping shall be run above the floor.
 - k. All oil supply and return lines of copper tubing shall be connected by flare fittings only. All fittings shall be accessible for service or replacement. No compression fittings shall be used on a supply or return oil line unless it is for the introduction of the lines at the top of the tank with a single or double tap bushing.

8. Exhaust System:
 - a. Comply with NFPA #211
 - b. ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
 - c. Exhaust Connector: Flexible type.
 - d. Exhaust Silencer: Maximum available sound attenuation – critical application/noise sensitive.
 - e. Exhaust system will be insulated by Section 230700, coordinate work.
 - f. Provide adjustable roof flashings that are compatible with the roofing material specified in Division 7.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

- A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
- B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
- C. Relief Valves: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
- D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
- E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

- F. Discharge Cone: Closed or open type.
- G. Hose Valve Manifold Assembly:
 - 1. Standard: Comply with requirements in NFPA 20.
 - 2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
 - 3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
 - 4. Automatic Drain Valve: UL 1726.
 - 5. Manifold:
 - a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
 - b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
 - c. Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
 - d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
 - e. Escutcheon Plate: Brass or bronze; rectangular.
 - f. Exposed Parts Finish: Polished.
 - g. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 FLOWMETER SYSTEMS

- A. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
- B. Pressure Rating: 175 psig minimum.
- C. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
- D. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter. Include bracket or device for wall mounting. Tubing Package: NPS 1/8 or NPS 1/4 soft copper tubing with copper or brass fittings and valves.

2.5 CONTROLLERS FOR DIESEL-DRIVE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ASCO Power Technologies, LP; Firetrol Products.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Hubbell Incorporated; Hubbell Industrial Controls.
 - 4. Joslyn Clark Corporation.
 - 5. Master Control Systems, Inc.
 - 6. Metron, Inc.
 - 7. Tornatech.

B. General Requirements for Controllers:

1. Comply with NFPA 20 and UL 218.
2. Listed by an NRTL for diesel-engine driver for fire-pump service.
3. Combined automatic and nonautomatic operation.
4. Factory assembled, wired, and tested.

C. Method of Starting:

1. Pressure-switch actuated.
 - a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
 - b. System pressure recorder, electric ac driven, with spring backup.
 - c. Programmable minimum-run-time relay to prevent short cycling.
 - d. Programmable timer for weekly tests.
2. Dual, redundant dc-voltage battery units, with automatic changeover.
3. Emergency Control: Bypasses all automatic control circuits during manual starting and running.
4. Automatic engine start on loss of ac power to the controller.

D. Method of Stopping: Per NFPA 20.

E. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:
 - a. Microprocessor-based logic controller, with multiline LCD readout.
 - b. Membrane keypad.
 - c. LED alarm and status indicating lights.
3. Local Alarm and Status Indications:
 - a. Controller power on.
 - b. Engine-lubrication-system critically low oil pressure.
 - c. Engine-jacket coolant high temperature.
 - d. Engine fail-to-start.
 - e. Engine overspeed shutdown.
 - f. Low fuel level.
 - g. Missing or failed battery.
 - h. Battery charger failure.
 - i. System overpressure.
 - j. Fuel injector malfunction.
4. Audible alarm.

F. Optional Features:

1. Extra Output Contacts:
 - a. One Form C contacts for low pump-room temperature.
 - b. One each, Form C contacts for high and low fuel levels.
 - c. One each, Form C contacts for high and low reservoir levels.
2. Door-mounted thermal or impact printer for alarm and status logs.
3. Operator Interface Communications Ports: USB, Ethernet, and RS485.
4. Powered louver contacts.
5. Powered engine-oil heater contacts.

G. Battery Charger System:

1. Built-in, independent, dual battery chargers with automatic changeover.
2. Standard: UL 1236.

2.6 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

A. General Requirements for Pressure-Maintenance-Pump Controllers:

1. Type: UL 508 factory assembled, -wired, and tested, across-the-line; for combined automatic and manual operation.
2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
3. Factory assembled, wired, and tested.
4. Finish: Manufacturer's standard color paint.

B. Rate controller for scheduled horsepower and include the following:

1. Fusible disconnect switch.
2. Pressure switch.
3. Hand-off-auto selector switch.
4. Pilot light.

2.7 ENCLOSURES

A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.

1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

1. Running period timer.

2.8 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.9 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
 - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. Fire pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting:
 - 1. Provide a cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
 - 2. Base must be grouted to its full depth.
 - 3. Comply with requirements for seismic control devices per NFPA 13 and NFPA 20.
- C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

- D. Support piping and pumps separately so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping.
- F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings.
- G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- H. Install fuel system according to NFPA 20. Field modify the fuel tank legs if needed to achieve proper tank height relative to the fuel pump centerline.
- I. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.
- J. Install exhaust-system piping for the diesel engine.
 - 1. Provide a flex connector between the engine and the exhaust pipe. The flex connector shall not be used for misalignment.
 - 2. Piping insulation will be provided by Section 230700.
 - 3. Piping shall be provide in accordance with Section 232113.
 - 4. Back pressure in the exhaust system shall not exceed the engine's limit. Sprinkler contractor shall confirm size and provide larger if needed.
 - 5. Extend to the roof as indicated. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.
 - 6. Provide a roof flashing suitable for high temperatures.
 - 7. Provide a rain cap on the outlet. Exhaust outlet shall be 4 feet above the roof.
 - 8. Install condensate-drain piping. Extend drain piping from low points of exhaust system to condensate traps and to floor drain.
- K. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
- L. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- M. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

- A. Align pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.

- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

- A. Install piping adjacent to pumps and equipment to allow service and maintenance.
- B. Connect relief-valve discharge to drainage piping or point of discharge.
- C. Connect flowmeter-system meters, sensors, and valves to tubing.
- D. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit. Comply with requirements for diesel-engine-driver fire-pump controllers specified in Section 21 39 00 "Controllers for Fire-Pump Drivers."
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
 - 2. Test according to NFPA 20 for acceptance and performance testing.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 31 16

SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 23 05 00, common work results for plumbing are included in this section.

END OF SECTION 22 05 00

SECTION 22 05 16 – BRAIDED EXPANSION LOOPS AND FITTINGS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 23 05 16, braided expansion loops and fittings for plumbing piping are specified in this Section.

END OF SECTION 22 05 16

SECTION 22 05 19 – THERMOMETERS AND PRESSURE GAUGES FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 23 05 19 for thermometer and pressure gauges for plumbing.

END OF SECTION 22 05 19

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 23 05 29 for hangers and supports for plumbing piping and equipment.

END OF SECTION 22 05 29

SECTION 22 05 48 - SEISMIC CONTROLS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 23 05 48 for seismic controls for plumbing.

END OF SECTION 22 05 48

SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 23 05 53 for identification for plumbing piping and equipment.

END OF SECTION 22 05 53

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 23 07 00 for plumbing insulation.

END OF SECTION 22 07 00

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"
 - 2. Division 22 Section "Hangers and Supports"
 - 3. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.

1.2 SUMMARY

- A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.
- B. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.
- C. General layout shown, provide piping to fixtures as required by the Maine Plumbing Code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

1.3 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Escutcheons.
 - 6. Sleeves and sleeve seals.
 - 7. Water penetration systems.

- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

- B. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.
- C. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.
- D. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," and NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for combined fire-protection and domestic water service piping to building.
- E. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.
- F. Water line components shall be lead-free.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- C. Transition Couplings for Underground Pressure Piping: AWWA C219, metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 DUCTILE-IRON PIPING

- A. From inside face of exterior wall to a distance of approximately 5 feet outside of building (coordinate with Division 2). Provide flanged and anchored connection to interior piping. Materials shall be approved by the local water utility.
- B. Ductile iron pipe shall meet requirements of AWWA Standard C-151 (latest revision) and be cement lined and seal coated to meet AWWA Standard C-104 (latest revision). Joints shall meet requirements of AWWA C-111 (latest revision). Interior seal coated, bituminous paint oil cut, emulsion not acceptable, thickness minimum of 2 mils dry film thickness. Exterior bituminous coated with minimum of 2 mils dry film thickness. Class 52 wall thickness, 4-inch diameter through 12-inch diameter inclusive. Mechanical joint pipe to be furnished with gland, gaskets and Cor-Ten bolts and nuts.
- C. Ductile Iron Fittings Including Bends, Reducers, Off-Sets, Tees And Sleeves: Material shall be ASTM A536 latest, grade 70-50-05, in accordance with AWWA C153 (latest revision). Fittings shall be cement lined AWWA C104 (latest revision) or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116. Interior seal coated AWWA C104 with minimum of 4 mils dry film thickness. Exterior bituminous coated, 4 mils minimum dry film

thickness or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116. Mechanical joint with accessories furnished: D.I. glands, gaskets, Cor-Ten T-bolts and nuts. Pressure Rating: Class 350 pressure rating in accordance with AWWA C153.

2.3 COPPER TUBING

- A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
 4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 5. Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
- C. Mechanically formed copper or steel tee connections are not acceptable.

2.4 AQUATHERM PIPING

- A. Pipe shall be Aquatherm Greenpipe, or Greenpipe Faser, available from Aquatherm, Inc. Domestic hot water shall contain a fiber layer (faser) to restrict thermal expansion. As proof of Aquatherm's demanding quality standards, all properly installed Aquatherm pipe systems carry a 10-year warranty for property damage liability coverage of up to \$15 million per damage event. This warranty covers the pipes, the fittings, and any incidental damage caused by material failure. The policy also provides an additional \$15 million for personal injury.
- B. Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in a three layer extrusion process. Domestic hot water shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389. All pipe shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.
- C. Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled

materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.

- D. Where indicated on the drawings that a Plenum-rated Piping System is needed, then the pipe shall be pre-insulated or field insulated, and when tested with standard un-insulated fittings per CAN/ULC-S102.2-03 or ASTM E84, the system consisting of wrapped or coated pipe and bare fittings shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.
- E. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a Factory applied, UV-resistant coating or alternative UV protection.
- F. If heat tracing is specified for the piping, it should be installed on the pipe interior or exterior, and it must be suitable for use with plastic piping and self-regulating to ensure the surface temperature of the pipe and fittings will not exceed 70°C (158°F).
- G. Where up to 1 inch of standard insulation is indicated in Section 22 07 00, a factory installed, thermal (radiant, conductive, and convective) and vapor barrier insulation shall be provided. Where more than 1 inch of standard insulation is indicated in Section 22 07 00, additional overlap of factory installed, thermal (radiant, conductive, and convective) and vapor barrier insulation shall be provided to ensure equivalent thermal resistance. The thick wall, self insulating fittings do not require an additional vapor barrier for the piping system to meet this performance level. The thermal barrier is UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth. The pipe with the integral thermal barrier with standard unprotected fittings shall meet the ASTM E84 and the CAN/ULC S102.2 requirements for a Flame Spread Rating of 25 and Smoke Development rating of 50.
- H. Manufacturer shall warrantee pipe and fittings for 10 years to be free of defects in materials or workmanship. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system do to defects in materials or workmanship.

2.5 PEX DOMESTIC WATER PIPING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. PEX-a manufacturer system warranty shall cover tubing for a duration of 30 years from the date of installation.
 - 1. Uponor Wirsbo hePEX (Basis of Design)
 - 2. Rehau
 - 3. Mr. PEX
- B. Code approved:
 - 1. International Code Conference (ICC) – International Plumbing Code (IPC)
 - 2. Uniform Plumbing Code (UPC)
 - 3. Comply with ANSI/NSF Standard 14.
 - 4. Comply with ANSI/NSF Standard 61

5. Certification of flame spread/smoke development rating of 25/50 in accordance with ASTM E84 provided the installation meets one of the following requirements.
 - a. Tubing spacing is a minimum of 18 inches apart for the following sizes: 3/8" through 3/4".
 - b. Tubing is wrapped with 1/2" fiberglass insulation with a flame spread of not more than 20 and a smoke-developed rating of not more than 30 and a nominal density of 4.0 to 4.5 pcf. Tubing can run with three tubes separated by zero inches and then 18 inches between the next group of three tubes for the following sizes: 3/8" through 2".

C. Tubing

1. Material: Crosslinked polyethylene (PEX) manufactured by PEX-a or Engel method
2. Type: Wirsbo AQUAPEX
3. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency
4. Standard grade hydrostatic design and pressure ratings from PPI
5. Fire-rated assembly listings in accordance with ANSI/UL 263
 - a. UL Design No. L557 — 1-hour wood frame floor/ceiling assemblies
 - b. UL Design No. K913 — 2-hour concrete floor/ceiling assemblies
 - c. UL Design No. U372 — 1-hour wood stud/gypsum wallboard wall assemblies
 - d. UL Design No. V444 — 1-hour steel stud/gypsum wallboard wall assemblies
6. Minimum Bend Radius (cold bending): No less than six times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.
7. Nominal Inside Diameter: Provide tubing with nominal inside diameter, in accordance with ASTM F876 as indicated.

D. Fittings

1. Material: Fitting assembly is manufactured from material listed in paragraph 5.1 of ASTM F1960.
2. Material Standard: Comply with ASTM F1960.
3. Type: PEX-a cold expansion fitting. Assembly consists of the appropriate ProPEX insert with a corresponding ProPEX Ring.

E. Manifolds

1. Material
 - a. Type L copper body with UNS 3600 series brass ProPEX outlet connections
 - b. Engineered Plastic (EP) body with ProPEX outlet connections
2. Manifold Type
 - a. Uponor ProPEX 1" Copper Manifold
 - b. Uponor engineered plastic (EP) Manifold

3. All manifolds manufactured with the appropriate-sized ProPEX fittings on the manifold supply inlets.

F. Accessories

1. Angle stops and straight stops that are compatible with PEX tubing are supplied by the PEX tubing manufacturer.
2. Bend supports designed for maintaining tight radius bends are supplied by the PEX tubing manufacturer.
3. ProPEX expander tool to install the ASTM F1960 compatible fittings are supplied by the PEX tubing manufacturer.
4. The tubing manufacturer provides clips and/or PEX rails for supporting tubing runs.
5. All horizontal tubing hangers and riser clamps are epoxy-coated material.

2.6 VALVES

A. Ball Valves

1. The valve body and adapter shall be constructed using Lead Free brass. Lead Free ball valves shall comply with state codes and standards, where applicable, requiring reduced lead content.
2. ½" to 2" ball valves: 2-piece full port Lead Free brass ball valves: The valve must have a blowout proof pressure retaining 316 stainless steel stem, 316 stainless steel ball, virgin PTFE seats, seals, stem packing seal and thrust washer. Valve must have adjustable packing. Valves with O-ring stem seal only are not acceptable. Pressure rating no less than 600psi WOG non-shock, 150psi WSP. Valve shall be manufactured to the MSS-SP-110 standard and shall be a Watts Series LFB6080 (threaded) or LFB6081 (solder).
3. Valve sizes 2-1/2" to 4" threaded, shall be rated to 400psi WOG non-shock and 125psi WSP. Valve sizes 2-1/2" to 3" solder shall be rated to 400psi WOG non-shock and 125psi WSP. Valve shall be a Watts Series LFFBV-3C (threaded) or LFFBVS-3C (solder).
4. Provide locking handle where indicated.
5. Aquatherm Greenpipe: Valves shall be manufactured in accordance with the manufacturer's specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
6. Comply with MSS SP-110.

- B. Swing check valves: Valves shall be manufactured out of Lead Free brass and be pressure rated to 125psi WSP, 200psi WOG non-shock. Valve shall have metal-to-metal seating, tee pattern design and solder end connections. The Lead Free brass check valves shall comply with state codes and standards, where applicable, requiring reduced lead content. Valve shall be a Watts Series LFCVS.

C. Wafer Check valves:

1. Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between 2 standard Class 125 flanges. Construct iron body valves with pressure containing parts of valves with materials conforming to ANSI/ASTM A 126, Grade B. Support hanger pin by removable side plug.

2. 2" and Larger: Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal: Nibco W920-W, Stockham WG970, Metraflex C-125, Hammond 9253, Milwaukee 1400, Watts ICV/ICV-F series, or approved equal.

D. Swing check valves:

1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B
2. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71
3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
4. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413B, Stockham B319, Milwaukee 509 or approved equal.
5. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-B, Stockham B309, Milwaukee 1509 or approved equal.
6. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Hammond IR1124, Nibco F918-B, Stockham G931, Milwaukee F2974, Watts 411 or approved equal.

- E. Refer to Division 22 Section "Plumbing Specialties" for balancing and drain valves.

2.7 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Hyspan Precision Products, Inc.
 4. Mercer Rubber Co.
 5. Metraflex, Inc.
 6. Universal Metal Hose; a Hyspan company
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing. Working-Pressure Rating: Minimum 200 psig. End connections compatible with piping.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing. Working-Pressure Rating: Minimum 200 psig. End connections compatible with piping.

2.8 WATER METERS

- A. Provide per Portland Water District requirements.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated. Piping 5" and larger: Grooved joints may be used on aboveground grooved-end piping.
- C. Mechanically formed tee-branch outlets and brazed joints shall not be used.
- D. Underground Domestic Water Service Piping: Ductile-iron pipe; mechanical- or push-on-joint, ductile-iron fittings; and restrained, gasketed joints.
- E. Aboveground Domestic Water or Non-Potable Water Piping: Use the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Type L copper, PEX, or Aquatherm.
 - 2. NPS 2.5 to 3: Type L copper, or Aquatherm.
 - 3. NPS 4 to NPS 6: Type L copper or Aquatherm.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball valves for piping NPS 3 and smaller. Use cast-iron butterfly valves with flanged or grooved ends for piping NPS 4 and larger. Aquatherm: ball valves.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 3 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 4 and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Calibrated, memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.

3.4 VALVE INSTALLATION

- A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment.
- B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops.
- C. Install hose end drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

- D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Refer to Division 22 Section "Plumbing Specialties" for calibrated balancing valves.

3.5 PIPING INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation.
- B. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.
- C. Install underground ductile-iron piping according to AWWA C600 and NFPA 24.
- D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each domestic water service.
- F. Provide dielectric fittings as specified in Section 23 05 00.
- G. Install aboveground domestic water piping level and plumb.
- H. Provide firestopping as per Section 23 05 00 "Common Work Results for HVAC".
- I. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- J. Perform the following steps before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 - 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- K. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- L. Check plumbing specialties and verify proper settings, adjustments, and operation.
- M. Energize pumps and verify proper operation.

3.6 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Fusion Welded Aquatherm Joints:
 - 1. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
 - 2. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
 - 3. Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389 and the manufacturer's specifications.
 - 4. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

3.7 PEX PIPING INSTALLATION

- A. Install PEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.
- B. Do not install PEX tubing within 6 inches of gas appliance vents or within 12 inches of any recessed light fixtures.
- C. Do not solder within 18 inches of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
- D. Do not expose PEX tubing to direct sunlight for more than 30 days.
- E. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
- F. Use grommets or sleeves at the penetration for PEX tubing passing through metal studs.
- G. Protect PEX tubing with sleeves where abrasion may occur.
- H. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.
- I. Use tubing manufacturer-supplied bend supports where bends are less than six times the outside tubing diameter.
- J. PEX-a Piping Hanger Spacing: Install hangers for PEX-a piping with the following maximum spacing:
 - 1. 1 inch and below: Maximum span, 32 inches.
 - 2. 1¼ inch and above: Maximum span, 48 inches.
 - 3. PEX-a Piping Hanger Spacing with PEX-a Support Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations, with the following maximum spacing: Maximum span, 8 feet.

- K. PEX-a Riser Supports: Install CTS riser clamps at the base of each floor and at the top of every other floor. Install mid-story guides between each floor.
- L. Pipe Joint Construction: PEX-a Connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for F1960 connections.
- M. Pressurize PEX tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi above normal working pressure of the system.
- N. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32°F.
- O. Through-penetration Firestop
 - 1. Ensure compliance of one- and two-hour rated through penetration assemblies in accordance with ASTM E814.
 - 2. A list of firestop manufacturers that list PEX tubing with their firestop systems is available from the PEX tubing manufacturer.
- P. Related Products Installation: Refer to other sections listed in Related Sections paragraph herein for related products installation.

3.8 ROUGHING-IN FOR WATER METERS

- A. Rough-in domestic water piping and provide water meters according to utility company's requirements.

3.9 FLEXIBLE CONNECTOR INSTALLATION

- A. Provide flexible connectors in suction and discharge piping connections to each domestic water pump. Domestic water temperature maintenance pumps do not require flexible connectors.

3.10 HANGER AND SUPPORT INSTALLATION

- A. Hanger, support, and anchor devices are specified in Division 22 Section "Hangers and Supports."

3.11 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water service piping. Use transition fitting to join dissimilar piping materials.

- D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the equipment and fixtures as shown on the plans.
- E. Connect water piping in sizes indicated, but not smaller than sizes of unit connections.
- F. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.12 FIELD QUALITY CONTROL

- A. Follow local code requirements.
- B. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Test domestic water piping as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- D. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch. Adjust calibrated balancing valves to flows indicated.

3.13 CLEANING

- A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses. Clean and disinfect domestic water piping per code requirements or administrative authority requirements. Sample procedure as indicated:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following: Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 22 11 16

SECTION 22 11 19 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"

1.2 SUMMARY

- A. This Section includes plumbing specialties.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Piping: 125 psig.
 - 2. Sanitary Waste and Vent Piping: 10-foot head of water.
 - 3. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data
- B. Field test reports.

1.6 QUALITY ASSURANCE

- A. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- E. Water line components shall be lead-free.
- F. NSF Compliance: Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

- A. Provide access panels to concealed valves, cleanouts, and components that require service access. All components shall have proper access in accordance with manufactures' recommendations. Refer to Section 22 05 00.

2.2 BACKFLOW PREVENTERS

- A. Manufacturers:
 - 1. Ames Co., Inc.
 - 2. Cla-Val Co.
 - 3. Apollo
 - 4. CMB Industries, Inc.; Febco Backflow Preventers.
 - 5. Conbraco Industries, Inc.
 - 6. Watts Industries, Inc.; Water Products Div.
 - 7. Zurn Industries, Inc.; Wilkins Div.
- B. General: ASSE standard, backflow preventers.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
 - 3. Interior Components: Corrosion-resistant materials. AWWA C550 or FDA-approved
 - 4. Exterior Finish: manufacturer's standard.
 - 5. Strainer: On inlet, lead-free.
 - 6. Lead free.
 - 7. Backflow preventers for hot water over 110F shall be a listed type for that application.
- C. Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

- D. Hose-Connection Vacuum Breakers: Watts Series 8FR; ASSE 1011, nickel plated, with non-removable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.
- E. Double-Check Backflow Prevention Assemblies:
 - 1. Watts Series LF007 (2-1/2" and smaller)
 - 2. Watts Series LF709 (3" and larger)
 - 3. ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 - 4. Lead-free
- F. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include ball or gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
 - 1. Provide lead-free construction.
 - 2. Provide air gap fitting.
 - 3. Provide lead-free bronze strainer.
 - 4. Febc LF860 or LF880V. Confirm available space.

2.3 WATER METERS

- A. Service meter will be furnished by the Portland Water District; contractor shall pay for meter.

2.4 THERMOSTATIC WATER MIXING VALVE PACKAGE **TMV-1**

- A. Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. Lawler Manufacturing Company, Inc.
 - 3. Leonard Valve Company.
 - 4. Powers; a division of Watts Water Technologies, Inc.
 - 5. Symmons Industries, Inc.
- B. Basis of Design: Leonard Megatron 6NB-LF complete water temperature control station.
- C. Furnished complete with:
 - 1. Wetted surface area of this product contains less than one quarter of one percent (0.25%) of lead by weight
 - 2. 2" hot and cold inlet connections (copper tube)
 - 3. 2" mixed outlet connection (copper tube)
 - 4. 1 1/4" return line size with piping method #4.
 - 5. Thermostatic water mixing valve with DURA-trol solid bimetal thermostat (with Extended 7 Year Limited Warranty) directly linked to hot and cold valve porting,

- adjustable high temperature limit stop set for 120°F, color-coded dial: C-H, locking temperature regulator, integral checkstops.
6. Full port ball valve, pressure gauge on mixed water outlet piping of large mixing valve.
 7. Dial thermometer (range: 0 to 140°F and pressure gauge on mixed water outlet of the system.
 8. Outlet Test Connection with ball valve and ¾" hose connection with cap
 9. Full port ball valve mounted downstream of test connection on mixed water outlet of the system
 10. Inlet piping manifold with full port ball valves and dial thermometers (20 to 240°F on hot supply, 0 to 140F cold supply) on hot and cold supply inlets
 11. Return piping, 1", with aquastat, circulator, dial thermometer (0 to 140°F), balancing valve (with positive shutoff) to balance system, and check valve
 12. Aquastat with temperature differential of 5 to 30°F.
 13. Circulator wiring box to include a GFCI switch, red and green lights. The GFCI switch will be used to turn the circulator on or off for setup. Green light will indicate when circulator is running and red light will indicate when circulator is not running because of a temperature rise.
 14. Bypass piping, 1 ¼", with check valve and isolation ball valve to bottom port of small mixing valve
 15. System mounted on strut, galvanized. Strut shall be assembled with three hole flat angle plate on corners, four-hole tee plates or two hole flat plate connectors on all other support pieces using 3/8" grip-lock nuts and 3/8"x 1" hex head cap screws, washers and lock washers.
 16. Factory pre-assembled and tested as a complete system
 17. Contractor shall provide field-required electrical connections.
- D. Circulator Pump (RCP-1) shall be designed specifically for Hot Water Recirculation applications. Pump shall be by Grundfos, Wilo, Taco, or Bell & Gossett. Provide the following features:
1. Refer to plumbing pump schedule on the plans.
 2. Wet rotor design for quiet, maintenance free operation.
 3. Stainless Steel rotor cladding and canister construction to prevent corrosion.
 4. Composite impeller design for optimal application performance.
 5. Built-in 6 foot, 115 volt ac line cord with a NEMA, 3 prong male plug.
 6. Built-in 24 hour programmable timer.
 7. UL Recognized strain relief and wire connections.
 8. Fully UL Recognized.
 9. Each unit shall be run and High Pot. tested.
 10. Bronze sweat connections.
 11. Provide circuit setter for balancing.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

- A. 3" and smaller: Y-type strainer shall be domestically manufactured, and conform to MIL-S-16293, and be ANSI 3rd party certified to comply with states' lead plumbing law 0.25% maximum weighted average lead content requirement. The main body shall be low lead bronze (ASTM B 584), the access cover shall be yellow brass (ASTM B 16) or cast bronze (ASTM B 584), the strainer screen shall be 300 series stainless steel, 20 mesh. Screens shall be accessible

for cleaning without removing the device from the line. The “Y” type strainer shall be a WILKINS Model YBXL. Drain: Pipe plug.

- B. 4” and larger: The lead-free cast iron “Y” type strainer shall be in compliance with MIL-S-16293F Type 2. The main body and access cover shall be cast iron (ASTM A 126 Class B) and coated with a FDA approved epoxy coating inside and out. The integral strainer screen shall be accessible for cleaning without removing the device from the line. The Cast Iron “Y” type strainer shall be a WILKINS Model FSC-DOM. Pressure/temperature: 200 psi @ 150°F WOG; End connections: Flanged Class 125 lb. Drain: Factory-installed, hose-end drain valve.

2.6 WASHING MACHINE HOOKUPS W

A. Outlet Boxes

1. Manufacturers:

- a. Acorn Engineering Company.
- b. Gray, Guy Manufacturing Co., Inc.
- c. IPS Corporation.
- d. LSP Products Group.
- e. Oatey.
- f. Symmons Industries, Inc.
- g. Zurn Industries, Inc.; Jonespec Div.

2. General: Outlet boxes with supply fittings complying with ASME A112.18.1M. Include box with faceplate, services indicated for equipment connections, and fire-retardant-treated-wood blocking between studs.

3. With hot- and cold-water hose connections, drain, and the following:

- a. Box and Faceplate: White Powder Coat on Cold Rolled Steel
- b. Surface-mounted for concrete or CMU walls, recess for stud walls.
- c. Shutoff Fitting: Combination, single lever.
- d. Supply Fittings: Two NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
- e. Drain: NPS 2 standpipe, P-trap, and direct waste connection to drainage piping.

- B. Washing Machine Drain Pan: Provided by Owner, no piped drain.

- C. Provide braided hose connectors, Watts Series FS-CWM-S “FloodSafe” Flexible Braided Stainless Steel Water Supply Connectors, designed specifically for washing machine hookups. They shall include a shutoff device on the inlet side to protect against catastrophic water damage. There are no mechanical moving parts during normal operation and no power source shall be required. FloodSafe connectors shall consist of PVC tubing jacketed with braided stainless steel, and permanently attached, brass, compression end fittings.

1. Length: 60”.
2. UPC listed
3. Connector shall be pressure rated to 125psi
4. Supplied with standard brass female hose bibb fittings at each end of the flexible connector.

2.7 HYDRANTS AND HOSE BIBBS

A. Manufacturers:

1. Josam Co.
2. Murdock, Inc.
3. Simmons Manufacturing Co.
4. Smith, Jay R. Mfg. Co.
5. Tyler Pipe; Wade Div.
6. Watts Industries, Inc.; Drainage Products Div.
7. Woodford Manufacturing Co.
8. Zurn
9. MAPA Products

B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.

1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
2. Outlet: ASME B1.20.7, garden-hose threads.
3. Operating Keys: One with each key-operation hydrant.

C. Non-freeze Concealed-Outlet Wall Hydrants **FPWH-1**: Zurn Z1322-EZ encased Ecolotrol anti-siphon; ASSE 1019, 3/4" pipe connection; automatic draining with flush-mounting box with cover, integral non-removable hose-connection backflow preventer, casing and operating rod to match wall thickness, concealed outlet, and wall clamp. Provide nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover.

D. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS [1/2] [3/4] threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral non-removable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.

1. Finish for Equipment Rooms: Rough bronze.
2. Finish for Finished Rooms: Chrome or nickel plated.
3. Operation for Equipment Rooms: Wheel handle.
4. Operation for Finished Rooms: Operating key.
5. Include operating key with each operating-key hose bibb.
6. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 WATER HAMMER ARRESTORS

A. Lead-free 0.25% maximum weighted average lead content requirement, consist of a copper body with a low lead brass hexagonal male pipe threaded inlet, an acetal, polycarbonate or low lead brass piston with Buna Nitrile or EPDM o-rings and lead free solder; ASSE® Listed 1010, ANSI A112.26.1. The device shall be pre-charged and sealed at the factory. The Water Hammer Arrestor shall be a WILKINS Model 1250XL.

2.9 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Stack Flashing Fittings:

1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.10 AIR-GAP FITTINGS

- A. Dishwasher: ASSE 1021, fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm; and inlet pressure of at least 5 psig at temperature of at least 140°F. Provide ports for garbage disposal or dishwasher hoses as required; Airgap International, Inc. or approved equal.
- B. Fixed Air-Gap Fittings: Zurn Z1024/Z1025 or Precision Plumbing Products ; manufactured cast-iron or bronze drainage fitting with semi-open top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 CLEANOUTS

A. Manufacturers

1. Zurn
2. Smith, Jay R. Mfg. Co.
3. Josam Co.
4. Tyler Pipe, Wade Div.
5. Watts Industries, Inc., Drainage Products Div.
6. Mifab

B. Cleanouts shall be easily accessible and shall be gastight and watertight. Provide a minimum clearance of 24 inches for the rodding. Size of cleanout shall be same as pipe size through 4". Pipes 4" and larger shall have 4" cleanouts.

C. Floor Cleanouts: Mifab C1000 Series floor cleanout with heavy-duty nickel-bronze or stainless steel adjustable top.

1. Compliance: ANSI/ASME A112.36.2M.
2. Load Rating: Up to 7,499 pounds.
3. Body: A1, 8-inch diameter body. Lacquered, ASTM A 48, Class 25 cast iron body with anchor flange. O-ring secondary gasket seal. 4-inch; 4"NPS machined integral body threads.
4. Combined Access Cover and Plug Top Assembly: Heavy-duty, round, 5-inch diameter; square, 5-inch by 5-inch (for tile insertion), adjustable, Type 304 stainless steel top assembly with No. 4 satin finish. Neoprene primary gasket seal. Vandal-resistant stainless steel screws.
5. When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts.
6. In carpeted areas, provide carpet cleanout markers.

D. Cleanouts shall consist of "Y" fittings and (1/8 inch) bends with brass or bronze screw plugs.

E. Provide cleanouts at or near the base of the vertical stacks with the cleanout plug located approximately 24 inches above the floor. If there are no fixtures installed on the lowest floor,

the cleanout shall be installed at the base of the stack Cleanout shall consist of sanitary tees. .
Extend the cleanouts to the wall access cover; Mifab 1400 Series.

- F. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

2.13 FLOOR DRAINS

A. Manufacturers

1. Zurn Industries, Inc
2. Jay R. Smith Mfg. Co.
3. Tyler Pipe, Wade Div.
4. Watts Industries, Inc
5. Mifab

- B. Floor drains shall comply with ASME A112.21.1M.

- C. Provide outlet type as required by piping system used. See plans for outlet size.

- D. Provide ½” trap primer connection as indicated on plans.

- E. **FD-1:** mechanical & fire pump rooms; ZURN Z526-P 12" diameter top drain, Dura-Coated cast iron body with 4" bottom outlet, seepage pan and adjustable extension frame with medium-duty cast iron deep slotted grate.

- F. **FD-2:** mechanical & fire pump rooms; ZURN Z525-P 9" diameter top drain, Dura-Coated cast iron body with 3" bottom outlet, seepage pan and adjustable extension frame with medium-duty cast iron deep slotted grate.

- G. **FD-3:** bathroom and finished areas; ZURN ZN415BZ-P, Dura-Coated cast iron body with 2" bottom outlet, combination invertible membrane clamp and adjustable collar with seepage slots, and "TYPE BZ" polished nickel bronze light-duty leveling strainer.

- H. **FS-1:** Kitchen Floor Sinks - J. R. Smith Figure 3001, 12" square with 1/2" grate and dome strainer.

- I. Garage Floor Drains: Provided by site contractor.

2.14 TRAP SEAL PRIMER VALVES

A. Manufacturers:

1. Precision Plumbing Products, Inc.
2. Josam Co.
3. Watts Industries, Inc.; Water Products Div.
4. Zurn Industries, Inc.; Jonespec Div.

- B. **TP-1:** PPP Model MP-500-115V mini-prime electronic trap priming manifold; UL and UPC listed.
1. Primer shall be an electronically activated trap priming device. Primer functions at a pre-selected time, delivering potable water across an air gap funnel.
 2. The device shall be mounted higher than the drains it serves. Trap supply lines shall be sloped to discharge point.
 3. A preset timer energizes a normally closed electronic solenoid valve. Potable water flows across the air gap and is distributed via trap primer feed lines. The timer then de-energizes the solenoid allowing it to close until the next operational cycle.
- C. **TP-2:** Water-saver trap primer designed to be used in conjunction with a 1-1/4" sink outlet, to divert drain water: Zurn Z1021, chrome-plated polished cast brass body with cleanout, ground joint elbow with 1-1/2" NPT outlet, 1-1/2" slip nuts and washers, flexible primer tubing and compression fitting, and escutcheons.
- D. **TP-3:** Supply-Type Trap Seal Primer Valves (**TP**): Mifab Model MR-500 pressure drop activated, brass, trap seal primer. Tested and Certified: ASSE 1018; Listed: IAPMO and CSA; Operating Range: 20 to 125 psi; Line Pressure Drop to Activate: 3 psi.

2.15 ROOF DRAINS

- A. Roof Drains: Comply with ASME A112.21.2M.
- B. Manufacturers
1. MIFAB
 2. Josam Co.
 3. Froet Industries
 4. Smith, Jay R. Mfg. Co.
 5. Tyler Pipe, Wade Div.
 6. Watts
 7. Zurn
- C. **RD-1:** JOSAM 21500 Series coated cast iron Roof Drain, large polypropylene locking dome, WEJLOC® non-puncturing clamp ring with integral gravel stop, large sump with wide roof flange and bottom outlet.
- A. **RD-2:** JOSAM 22010 Series coated cast iron Roof Drain, medium beehive dome, non-puncturing clamp ring with integral gravel stop and medium sump with roof flange and bottom outlet.
- B. **RD-3:** JOSAM 23500-AE Series coated cast iron LEVELEZE® Roof Drain, square pedestrian grate set in square secured frame, WEJLOC® non-puncturing flashing collar with weep holes for 2" roof fill, bolted support ring, adjustable top with wide roof flange and large sump with anchor flange and bottom outlet. Roof drain at Roof Deck 5014: provide roof drain compatible with the paver system, see J7/A3.1 for section through the roof deck.

- C. **RD-4:** JOSAM 23730 Series coated cast iron Roof Drain, round pedestrian grate set in square secured frame, non-puncturing flashing collar with weepholes for 2" roof fill and small sump with wide roof flange and bottom outlet
- A. **RD-5:** JOSAM 24720 Series coated cast iron Roof Drain, parapet type, secured angle grate integral with flashing clamp, shallow sump with flashing flange and side outlet threaded connection.

2.16 GREASE INTERCEPTORS (EXTERIOR)

- A. Provided by site contractor.

2.17 OIL INTERCEPTORS

- A. Provided by site contractor.

2.18 HAIR AND SOLIDS INTERCEPTOR

- A. See specification section 224000 PLUMBING FIXTURES.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to hydronic systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
 - 4. Access shall be provided for testing, maintenance and repair. Locate backflow preventer between 2 feet and 5 feet above floor.
 - 5. Test of Backflow Prevention Assemblies: Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:
 - a. Data on Device Data on Testing Firm

- b. Type of Assembly Name
 - c. Manufacturer Address
 - d. Model Number Certified Tester
 - e. Serial Number Certified Tester No.
 - f. Size Date of Test
 - g. Location
 - h. Test Pressure Readings Serial Number and Test Data of Gauges
 - i. If the unit fails to meet specified requirements, the unit shall be repaired and retested.
- C. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- D. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.
- E. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.
- F. Trap primers:
1. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - a. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - b. Size: Same as floor drain inlet.
 2. Install trap seal primers in accordance with manufacturer's instructions.
 3. Cycle trap seal primers a minimum of 6 times to ensure optimum performance.
 4. Ensure flux and other debris is removed.
 5. Use only Teflon tape around threads. Do not use pipe dope or paste.
 6. Do not solder fittings directly onto inlet or outlet of primer.
 7. Do not install trap seal primers closer than 40 feet apart when using same potable water supply line.
 8. Mount trap seal primers in a vertical position 1 foot above finished floor for every 20 feet of floor drain trap make-up water line.
 9. Install union connection above trap seal primers.
 10. Install line shut-off valve upstream of trap seal primers to shut off water supply when performing maintenance on trap seal primers.
 11. Avoid direct installation to prevent foreign material from entering directly into trap seal primers.
- G. Install expansion joints on vertical risers, stacks, and conductors if indicated.
- H. Cleanouts:
1. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated: Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated. Locate at each change in direction of piping greater than 45 degrees. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping. Locate at base of each vertical soil and waste stack.

2. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
 3. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
 4. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- I. Install floor drains in accordance with manufacturer's instructions at locations indicated on the drawings.
1. Protect installed floor drains from damage during construction.
 2. Install floor drains at low points of surface areas to be drained.
 3. Install floor drains plumb, level, and to correct elevation.
 4. Ensure top of floor drains are flush with top of finished floor.
 5. Install floor drains using manufacturer's supplied hardware.
 6. Coordinate depressed/pitched slab with concrete contractor.
 7. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 8. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- J. Roof Drains:
1. Coordination:
 - a. Roof drains installed and flashed by roofing contractor. Coordinate with Division 7.
 - b. Roof drains furnished, insulated, and connected to piping by Division 22.
 2. Examine areas to receive roof drains. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.
 3. Install roof drains in accordance with manufacturer's instructions at locations indicated on the drawings.
 4. Install roof drains plumb, level, and to correct elevation.
 5. Install roof drains using manufacturer's supplied hardware.
 6. Protect installed roof drains from damage during construction.
- K. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- L. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- M. Install wood-blocking reinforcement for wall mounting and recessed-type plumbing specialties.
- N. Install individual shutoff valve in each water supply to plumbing specialties. Install shutoff valves in accessible locations.
- O. Install air vents at piping high points. Include ball valve in inlet.
- P. Install traps on plumbing specialty drain outlets.

- Q. Water hammer arrestors shall be installed at commercial dishwashers, solenoid valves, flush valve water closets, as shown on the plans and as recommended by Plumbing & Drainage Institute Standard PDI-WH-201. Locate units at the end of branch lines, between the last two fixtures served. Size units based on fixture unit total of branch. All branch pipes serving flush valve water closets shall have water hammer arrestors.
- R. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 WATER METER INSTALLATION

- A. Provide water meters, piping, and specialties according to AWWA M6 and utility's requirements.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect plumbing specialties to piping specified in other Division 22 Sections.
- D. Connect plumbing specialties and devices that require power according to Electrical Specification Sections.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and grease recovery units and their installation, including piping and electrical connections. Report results in writing. Representative shall train Owner's maintenance personnel to adjust, operate, and maintain.
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 11 19

SECTION 22 11 23.13 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes domestic water booster pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

1.5 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. ASME Compliance: Comply with ASME B31.9 for piping.
- C. UL Compliance for Packaged Pumping Systems:
 - 1. UL 508, "Industrial Control Equipment."
 - 2. UL 508A, "Industrial Control Panels."
 - 3. UL 778, "Motor-Operated Water Pumps."
 - 4. UL 1995, "Heating and Cooling Equipment."
- D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain protective coatings and flange's protective covers during storage.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 DUPLEX CONSTANT-SPEED BOOSTER PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bell & Gossett; a Xylem brand.
 - 2. Canariis Corporation.
 - 3. Grundfos Pumps Corporation U.S.A.
- B. Furnish and install a Canariis constant speed, variable flow factory assembled water booster system as manufactured by Canariis Corporation, Riverview, Florida. The unit shall be rated as scheduled.
- C. The booster system shall be warranted in writing against defects in materials or workmanship under normal use and service for a period of one year after date of original operation but not more than 18 months from date of shipment from the Company's factory when installed and used in accordance with good standard practice.
- D. The complete Packaged Pumping System, including pumps, motors, control equipment, ASME tanks, valves, fittings and manifolds must be UL Listed. In addition to the UL Listing for the complete system the control panel assembly must be separately listed under UL-508 Industrial Control Equipment.
- E. Factory Assembly
 - 1. The booster system shall be factory assembled on a steel skid including pumps, motors, valves, 3-inch Type L Copper suction and discharge manifolds, and all interconnecting piping, wiring and controls. Provide isolation valves on the suction and discharge of each pump. The valves shall be Butterfly Valves. Provide two 4 1/2 ANSI grade A, panel mounted gauges for indicating system suction and discharge pressure. All skid mounted components shall be factory finished in a high quality enamel paint.
 - 2. Individual pumps, motors, pressure regulating or check valves may be serviced with the booster system in operation, and all components shall be suitable for the maximum working pressure in the system.
- F. Pumps: System shall include horizontal mounted close-coupled end suction centrifugal pumps with ANSI flanged connections. Pump features to include foot supported casing, back pull out design, top centerline discharge with replaceable casing wear rings and hydraulically balanced impeller. Pump shall be cast iron bronze fitted construction with a replaceable shaft sleeve and mechanical seal suitable for a working pressure of 175 PSIG. Motor shall be NEMA close-coupled type with a JM shaft.

- G. Motors shall be manufactured in accordance with NEMA standards. Motors shall be selected so that they do not exceed name plate HP rating throughout the programmed sequence of pump operation.
- H. System Valves: Each pump discharge shall have a silent non-slam check valve sized for a maximum loss of 3 psi at design flow and be suitable for the maximum working pressure of the system.
- I. Hydro-Pneumatic Tank
 - 1. Provide a hydro-pneumatic tank with a carbon steel shell and a replaceable FDA approved heavy duty bladder to separate the air and water. No water shall come in contact with the metal walls of the tank. Features shall include an air fill valve, pressure gauge connection and bottom system connection suitable for 100% drawdown.
 - 2. The tank must be constructed in accordance with Section VIII of the ASME code and be N.B. stamped.
 - 3. The tank shall be mounted On Pump Skid and the tank feed line shall be connected between the lead pumps discharge and it's PRV to provide maximum tank storage.
- J. Lead Pump Operation: The lead pump shall run only as necessary to maintain system pressure and shall be controlled automatically by means of a pressure switch and minimum run timer to prevent short cycling.
- K. Lag Pump Sequencing: The lag pump shall be sequenced on and off automatically in accordance with the system demand. The lag sequence control shall be pressure switch operated with on delay and minimum run timers to prevent short cycling.
- L. Control Panel: Each system shall include a UL listed enclosed industrial control panel in a Nema-1 enclosure factory mounted and wired on the steel skid. The panel shall be furnished with Main Disconnect With External Handle and Fusing with through the door handle(s), magnetic starters with (3) leg overload protection, pump run lights, H-O-A selector switches, 115 volt fused control transformer, programmable controller and pump start, stop and sequence controls. Provide the following control panel features:
 - 1. Control Power (On-Off) Switch and Light
 - 2. Low Suction Pressure Shutdown Circuit With Auto Reset And Light
 - 3. Low System Pressure Circuit To Start Standby Pump(s) With Manual Reset And Light
 - 4. High Suction Pressure Shutdown Circuit With Auto Reset, Delay Timer And Light
 - 5. Audible Alarm With Silence Pushbutton
 - 6. Automatic Alternation
 - 7. System Temperature Probe And Purge
 - 8. Flow Switch To Limit Lead Pump On-Off Cycling
 - 9. Elapsed Time Meters
 - 10. Auxiliary Relay Contacts

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

- A. Equipment Mounting: Install booster pumps on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.
 - 1. Install shutoff valves on piping connections to booster-pump suction and discharge piping. Install ball, butterfly, or gate valves same size as suction and discharge piping.
 - 2. Install union, flanged, or grooved-joint connections on suction and discharge piping at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 22 11 16 "Domestic Water Piping."
 - 3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge piping.
 - 4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge piping.
 - 5. Install piping adjacent to booster pumps to allow service and maintenance.

3.4 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. After factory assembly, the packaged pumping system shall be hydrostatically tested as well as undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. All

controls, pump sequencing devices, alarms and instrumentation shall be tested and calibrated for proper operation during factory testing.

- B. The service of a factory trained representative shall be made available on the jobsite for start-up and instructing operating personnel.
 - 1. Perform visual and mechanical inspection.
 - 2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

- A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust pressure set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two Insert number visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

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

END OF SECTION 22 11 23

SECTION 22 13 16 – PLUMBING SANITARY AND STORM PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"
 - 2. Division 22 Section "Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.2 SUMMARY

- A. This Section includes soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.
- B. This Section includes storm-drainage piping inside the building and to locations indicated.
- C. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.
- D. General layout shown, provide piping to fixtures as required by the Maine Plumbing Code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

1.3 PERFORMANCE REQUIREMENTS

- A. Comply with the utility requirements for the connection of to the municipal utility services. Obtain and pay for all necessary permits from the applicable municipal department. Obtain authority to connect to their existing mains.
- B. Provide components and installation capable of producing piping systems with working-pressure ratings per local plumbing code.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.
- C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 CAST-IRON SOIL PIPING

- A. Hubless
 - 1. Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A-888 and CISPI Standard 301. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.
 - 2. Hubless couplings shall conform to CISPI Standard 310 for standard couplings or ASTM C-1540 for heavy duty couplings where indicated. Gaskets shall conform to ASTM C-564. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and local code requirements. Couplings shall be installed in accordance with the manufacturer's band tightening sequence and torque. Tighten bands with a properly calibrated torque limiting device.
- B. Hub and Spigot Cast Iron Soil Pipe and Fittings:
 - 1. Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A-74. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. Pipe and fittings to be Service (SV) Extra Heavy (XH)
 - 2. Joints can be made using a compression gasket manufactured from a neoprene elastomer meeting the requirements of ASTM C-564 or lead and oakum. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and local code requirements. The system shall be hydrostatically tested after installation to 10 ft. of head (4.3 psi maximum).

2.3 PVC DRAINAGE PIPING

- A. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D-1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D-1785 and ASTM D-2665. Fittings shall conform to ASTM D-2665.
- B. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and local code requirements. Solvent cements shall conform to ASTM D-2564, primer shall conform to ASTM F-656. The system to be manufactured by Charlotte Pipe and Foundry Co. or approved equal; and shall be intended for non-pressure drainage applications where the temperature will not exceed 140°F.

2.4 PVC PRESSURE PIPING

- A. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and local code requirements. Solvent cements shall conform to ASTM D-2564, primer shall conform to ASTM F-656. The system to be manufactured by Charlotte Pipe and Foundry Co. and is intended for pressure applications where the temperature will not exceed 140°F.
- B. Solid Wall: Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D-1784 and conform with National Sanitation Foundation (NSF) standards 14 and 61. Pipe shall be iron pipe size (IPS) conforming to ASTM D-1785. Fittings shall conform to ASTM D-2466.
- C. Foam Core: Pipe and fittings shall be manufactured from PVC compound with a cell class of 11432 per ASTM D-4396 for pipe and 12454 per ASTM D-1784 for fittings and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM F-891. Fittings shall conform to ASTM D-2665.

2.5 ABS PIPING

- A. ABS Pipe: ASTM D 2661, Schedule 40, solid wall. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

- B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.
- C. Aboveground and Underground, Soil, Waste, and Vent Piping: Use the following piping materials for each size range:
 - 1. Cast iron
 - a. Waste risers/stacks
 - b. Bistro drains
 - c. Boiler room drains – within boiler room
 - 2. PVC or Cast iron
 - a. Under slab
 - b. Concealed
 - c. Vents
- D. Vent Piping through roof/exposed above roof: Use any of the following piping materials for each size range:
 - 1. Cast iron
 - 2. Schedule 40 PVC DWV –not allowed in the lower Connector roof.
 - 3. ABS
- E. Elevator sump pump discharge piping: Type L sweated copper.
- F. Storm Drain Piping:
 - 1. Cast iron
 - 2. Schedule 40 PVC DWV
- G. Storm Drain Piping, heat traced: Cast iron

3.3 PIPING INSTALLATION

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.
- B. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation.
- C. Install cleanouts at grade and extend to where building drains connect to site piping.
- D. Install cleanout fitting with closure plug inside the building in force-main piping.
- E. Provide firestopping as per Section 23 05 00 "Common Work Results for HVAC".
- F. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

- H. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- I. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install drainage and vent piping at the minimum slopes as required by the local plumbing code.
- M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings." Gasketed Joints: Make with rubber gasket matching class of pipe and fittings. Hubless Joints: Make with rubber gasket and sleeve or clamp.

3.5 VALVE INSTALLATION

- A. Shutoff Valves: Install full-port ball valve on each pump discharge.
- B. Check Valves: Install swing check valve, downstream from shutoff valve, on each pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Hanger, support, and anchor devices are specified in Division 22 Section "Hangers and Supports."

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials. Connect storm drainage piping to roof drains and storm drainage specialties.
- C. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials. Connect drainage and vent piping to fixtures and equipment as shown on the plans. Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

- C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- D. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
- E. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 13 16

SECTION 22 14 29 - SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following: Division 22 Section "Common Work Results for Plumbing"

1.2 SUMMARY

- A. This Section includes:
 - 1. Sump pumps for elevator sump pits.

1.3 SUBMITTALS

- A. Product Data: Include performance curves, furnished specialties, and accessories for each type and size of pump indicated.
- B. Shop Drawings: Show layout and connections for pumps. Include setting drawings with templates, directions for installing foundation and anchor bolts, and other anchorages.
- C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- D. Maintenance Data: For each type and size of pump specified to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered.
- 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.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.

- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Weil Pump Co.
 - 2. Little Giant Pump Co.
 - 3. Weil Pump Co.
 - 4. Zoeller Pump Co.
 - 5. Liberty Pumps.
 - 6. Myers
 - 7. Stancor

2.2 ELEVATOR SUMP PUMP

- A. Basis of Design: Zoeller Oil Guard System, submersible, direct-connected sump pump. Approved equal: Liberty or ABS.
 - 1. Casing: Cast iron with metal inlet strainer, stainless steel handle. Include discharge companion flange suitable for plain-end pipe connection arranged for vertical discharge.
 - 2. Impeller: Cast iron, bronze, brass, or stainless steel.
 - 3. Pump and Motor Shaft: Steel, with factory-sealed, grease-lubricated ball bearings.
 - 4. Seal: ceramic carbon.
 - 5. Motor: Hermetically sealed capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
 - 6. Automatic reset thermal overload protected.
 - 7. Pump Discharge Piping: 1 ½" Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe or copper tube.
 - 8. Oil smart switch and alarm features:
 - a. Audible and Light alarms with dry contacts.
 - b. NEMA 4X watertight panel enclosure with lockable latch
 - c. Preset "On and off" points; UL508 approved switch.
 - d. Differentiates oil and water; 304-SS probes.
 - e. Alert maintenance personnel of high water or oil detection.
 - f. 20 foot piggyback electrical supply cord
 - g. 20 amp relay.
 - h. NEMA 3R alarm enclosure.
 - 9. Basin: concrete, see structural plans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections before pump installation.

3.2 CONCRETE

- A. Concrete for pits and sumps is specified in Division 3.

3.3 INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps and arrange to provide access for maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support piping so weight of piping is not supported by pumps.
- D. Submersible Sump Pumps:
 - 1. Set pumps in pit. Coordinate pit size.
 - 2. Coordinate location of GFI 3-prong grounded electrical receptacle, extension cords are not permitted.
 - 3. Drill a 3/16" hole in the discharge pipe below the check valve and sump cover to allow proper purging of air.
 - 4. Pit must be cleaned of debris after installation.

3.4 CONNECTIONS

- A. Install discharge pipe sizes equal to or greater than diameter of pump nozzles, and connect to storm drainage piping.
- B. Install swing check valve and ball valve on each pump discharge.
- C. Install electrical connections for power, controls, and devices.
- D. Electrical power and control components, wiring, and connections are specified in Electrical Specification Sections.
- E. Ground equipment. 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 ADJUSTING

- A. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

3.6 COMMISSIONING

- A. Final Checks before Starting: Perform the following preventive maintenance operations:

1. Lubricate bearings.
2. Disconnect couplings and check motors for proper direction of rotation.
3. Verify that each pump is free to rotate by hand. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
4. Verify that pump controls are correct for required application.

- B. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:

1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.
4. Confirm that alarm contact signals control system upon failure or high water level.

END OF SECTION 22 14 29

SECTION 22 35 00 – INDIRECT-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"

1.2 SUMMARY

- A. This Section includes indirect-fired water heaters.

1.3 SUBMITTALS

- A. Product Data: For each type and size of indirect-fired water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For indirect-fired water heaters to include in emergency, operation, and maintenance manuals.
- C. Warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of indirect-fired water heaters through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of indirect-fired water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including indirect-fired water heater, storage tank, and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period: From date of Substantial Completion: 5 years.

PART 2 - PRODUCTS

2.1 INDIRECT-FIRED STORAGE WATER HEATERS

A. Manufacturers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Viessmann
 - b. Amtrol
 - c. Buderus
 - d. Heat Transfer Products, Inc.

B. Performance Criteria

1. The DHW tank shall have a storage capacity of no less than 119 USG.
2. The tank shall be suitable for domestic hot water production in combination with a hot water heating system.
3. The tank shall be designed for use on heating systems with the following operating conditions:
 - a. Tank operating conditions: maximum operating pressure 150 psig at 210°F.
 - b. Heat exchanger coil operating conditions: maximum hot water operating pressure 220 psig at 392°F.

C. Construction

1. Basis of Design: Viessmann.
2. Each hot water storage tank shall have an integrated stainless steel, smooth-surfaced, non-finned, conically shaped, rectangular-coiled heat exchanger. Both the tank and heat exchanger shall be made of fully hygienic, high-alloy stainless steel, austenitic, chrome-nickel-steel, titanium stabilized (X6CrNiMoTi17122 - SA 240 - 316 Ti).
3. The 1¼" diameter internal tubular heat exchanger shall be designed with a large surface coil area in the lower portion of the tank to allow rapid and uniform heating of the water in the tank with a low pressure drop through the heat exchanger coil. The coil shall be designed so as to be both self-draining and self-venting, be non-finned with space between passes, and be tapered to allow full output from all passes of the coil.
4. The tank shall be equipped with a stainless steel sensor well.

5. Tank enclosure panels shall encase the tank with a minimum of 4" wrap-around foam insulation (HCFC-free). Brass NPT adaptors, for attachment of each threaded nipple to boiler water or domestic water piping, shall be factory supplied.
 6. Each tank shall have a front-mounted inspection / clean-out port, and be equipped with a thermometer registering tank water temperature.
 7. Four levelling feet shall be provided on the tank base to allow for easy adjustment.
 8. A 3/4" pressure and temperature relief valve shall be factory supplied and field installed to meet local code. The maximum pressure relief setting shall be 150 psi at 210°F.
- D. Certifications: The tank shall have the following approvals and listings, or be in compliance with: CSA, CRN, NY City approval, MA State approval.

PART 3 - EXECUTION

3.1 STORAGE WATER HEATER INSTALLATION

- A. Install indirect-fired water heaters on concrete bases. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing"
- B. Install indirect-fired water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install temperature and pressure relief valves in top portion of storage tank shells of indirect-fired water heaters with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Fill indirect-fired water heaters with water, purge, and startup in accordance with manufactures' recommendations.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to indirect-fired water heaters to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Remove and replace indirect-fired water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

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

END OF SECTION 22 35 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section "Common Work Results for Plumbing"
 - 2. Section 22 11 16 - Domestic Water Piping: Material and installation of piping systems, valves, and piping specialties.
 - 3. Division 22 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.2 SUMMARY

- A. Plumbing Fixtures
- B. Electric Water Coolers

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.
- B. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer. 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. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.

- D. 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.
- E. Faucets shall be low lead per NSF/ANSI 372 Low Lead Content.
- F. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- G. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

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.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Common Plumbing Fixture Requirements
 - 1. Fixtures shall be water conservation type in accordance with local, state, and federal requirements.
 - 2. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws.
 - 3. Fixture color shall be white except as specified herein.
 - 4. Provide combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
 - 5. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings.
 - 6. Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap.
 - 7. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view.
 - 8. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers.
 - 9. Fixture supports for off-the-floor fixtures shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

10. Provide access panels to concealed valves and components. All components shall have proper access in accordance with manufactures' recommendations. Refer to Section 22 05 00.
11. Mounting heights: Refer to Architectural Plans.

2.2 FLUSH VALVE WATER CLOSET – **P-1A** (ADA Accessible)

A. Manufacturers

1. American Standard, Inc.
2. Kohler Co.
3. Sloan
4. Toto
5. Zurn

B. Wall mounted back outlet white vitreous china siphon jet water closet with elongated bowl.

1. Basis of Design: American Standard AFWall Millennium FloWise.
2. 1.28 gpf floor mount bottom outlet bowl
3. Fixture shall qualify according to ASME test procedures as a high-efficiency water closet
4. Mounting height per architectural elevations.
5. 1-1/2" top spud for flushometer valve
6. ADA Compliant
7. 2 Bolt Caps
8. Seat: American Standard #5905.100; extra heavy duty open front less cover.
9. Flush valve: Sloan HET Royal 111-1.28-SG exposed flushometer with SaniGuard Antimicrobial Coating.
10. Water Closet carrier: Watts #ISCA-102, single horizontal, adjustable toilet carrier, heavy duty, mounted on concrete floor, epoxy coated cast iron fitting, epoxy coated ductile iron foot supports, 3" no hub waste, 2" no hub vent, 1000 lbs. static load. Minimum space required: 17" finished metal stud wall to back of pipe space.

2.3 TANK TYPE WATER CLOSETS **P-1B** (ADA Accessible)

A. Manufacturers

1. American Standard, Inc.
2. Kohler Co.
3. Toto
4. Zurn
5. Gerber

B. Floor Mounted bottom outlet white vitreous china siphon jet water closet with elongated bowl.

1. Basis of Design: American Standard "Retrospect Champion Pro" elongated toilet Model 212AA.104.
2. Features Champion® Flushing System
3. Vitreous china
4. High Efficiency Toilet (HET), ultra-low consumption, 1.28 gpf

5. Fixture shall meet or exceed EPA WaterSense® Criteria
 6. Toilet shall test to a 1,000g MaP Score at 1.28gpf
 7. Power-Wash rim shall scrub bowl with each flush
 8. Robust metal trip lever & metal shank fill valve
 9. Includes EZ-Install tools w/color match bowl caps
 10. Provide EverClean® Surface
 11. 4" piston-action Accelerator™ flush valve
 12. Fully-glazed 2-3/8" trapway
 13. 16-1/2" rim height
 14. 12" rough-in; Generous 9" x 8" water surface area
 15. Chrome finish trip lever is supplied
 16. Provide a 10 year warranty.
 17. ASME A112.19.2-2008/CSA B45.1-08 for Vitreous China Fixtures
- C. Floor Flange, (same material as the connecting pipe drain), with all brass bolts and with rubber gasket.
- D. Provide closet supply kit includes one chrome plated solid brass angle stop with wheel-handle, all brass stem and replaceable washer. The kit shall also include a 12" corrugated stainless-steel braided riser; chrome plated steel flange. ASME A112.18.1/CSA B125.1.
- E. Seats: Seat: #5214.110 Elongated traditional slow close solid plastic seat and cover
- 2.4 URINAL **P-2** (ADA Accessible)
- A. Manufacturers
1. American Standard, Inc.
 2. Kohler Co.
 3. Toto
 4. Sloan
 5. Zurn
- B. Wall mounted back outlet white vitreous china siphon jet urinal with elongated rim and extended sides for privacy.
1. Basis of Design: American Standard Model Washbrook 6590.001
 2. Ultra high efficiency, low flow consumption.
 3. Wash down flushing action and Integral flushing rim, designed for 1/8 GPF.
 4. 3/4" top spud inlet
 5. 100% factory flush tested
 6. All mounting hardware included
 7. Mounting height as per architectural elevations.
- C. Urinal Support: Jay R. Smith carrier: 0636 & 0637; urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Mounting height as per architectural plans.

D. Flushometer

1. Sloan Royal 186-0.125, exposed type; synthetic rubber diaphragm with linear filtered dual bypass
2. Chrome plated.
3. ¾" I.P.S. Wheel Handle Bak-check Angle Stop
4. High Back Pressure Vacuum Breaker
5. 1/8 GPF
6. Spud coupling for 3/4" concealed Back Spud Urinal
7. Elbow Flush connection
8. Exposed Parts chrome Plated
9. High copper, low zinc brass castings for dezincification resistance
10. Flush accuracy controlled by CID technology
11. Valve body, tailpiece and control stop shall be in conformance with ASTM Alloy classification for semi-red brass. Valve shall be in compliance with the applicable sections of ASSE 1037, ANSI/ASME A112.19.2.

2.5 LAVATORY – **P-3A** (ADA Accessible)

A. Lavatory Manufacturers:

1. American Standard
2. Kohler
3. Toto
4. Zurn

B. Oval drop in, self-rimming vitreous china counter mounted lavatory.

1. Basis of Design: American Standard Aqualyn Model 0476.028.
2. 20 3/8" x 17 3/8"
3. Front overflow
4. Mounting assembly complete with installation template and mounting screw set
5. Faucet: Chicago Faucet model 3500-4E2805ABCP, deck mounted single supply metering faucet, 4" fixed centers, 0.5 GPM non aerating spray, ceramic cartridge with 4" cover plate.
6. Drain: 304SS grid drain
7. P-trap: Heavy cast brass 1 1/4 x 1 1/2 adjustable trap with cleanout plug and 12 inch center to end. Furnished with slip nuts, 17 gauge seamless tubular brass wall bend, and steel shallow flange.
8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges; connections: 1/2" sweat x 3/8" OD.
9. Zurn Z1231 Concealed arm carrier.

2.6 LAVATORY – **P-3B** (ADA Accessible) - Apartments

A. Lavatory Integral with counter.

1. Faucet: Chicago Faucet model 3511-4E2805AB, deck mounted 4" fixed centers, hot and cold mixing faucet, 0.5 GPM non aerating spray, ceramic cartridge with 4" cover plate.
2. Drain: 304SS grid drain
3. P-trap: Heavy cast brass 1 1/4 x 1 1/2 adjustable trap with cleanout plug and 12 inch center to end. Furnished with slip nuts, 17 gauge seamless tubular brass wall bend, and steel shallow flange.
4. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.

2.7 LAVATORY – **P-3C** (ADA Accessible)

A. Lavatory Manufacturers:

1. American Standard
2. Kohler
3. Toto
4. Zurn

B. Oval drop in, self-rimming vitreous china counter mounted lavatory.

1. Basis of Design: American Standard Aqualyn Model 0476.028.
2. 20 3/8" x 17 3/8"
3. Front overflow
4. Mounting assembly complete with installation template and mounting screw set
5. Faucet: Same as P-3B.
6. Drain: 304SS grid drain
7. P-trap: Heavy cast brass 1 1/4 x 1 1/2 adjustable trap with cleanout plug and 12 inch center to end. Furnished with slip nuts, 17 gauge seamless tubular brass wall bend, and steel shallow flange.
8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.
9. Zurn Z1231 Concealed arm carrier.

2.8 STAINLESS STEEL SINKS – **P-4A** (ADA Accessible)

A. Sink Manufacturers:

1. Elkay Manufacturing Co.
2. Just Manufacturing Co.
3. Kindred
4. Advance Tabco

B. Faucet Manufacturers

1. Symmons
2. Delta Commercial
3. Chicago
4. Moen
5. Zurn
6. Kohler
7. American Standard

C. Top mounted self-rimming counter sink, 18 gauge; type 304 stainless steel with single control pull down kitchen faucet.

1. Basis of Design: Elkay LRADQ2521R, 25"x21 ¼" outside dimensions and 21"x15 ¾" inside dimensions.
2. ADA bowl depth: 6 1/2".
3. Three-hole punch, 4" on center.
4. Sink Faucet: American Standard Portsmouth Model #4285.300.F15, single control faucet with pull down spray, 1.5 GPM, provide cover plate. Washerless ceramic disc valve cartridge with integral check valves, braided flexible supply hoses with 3/8" compression connectors. Memory position valving, lead free.
5. Drain Opening: 3-1/2" off centered right location.
6. P-trap: McGuire 912CB heavy cast brass adjustable body, with slip nut, with cleanout, box flange and seamless tubular wall bend.
7. Drain: type 304 stainless grid drain
8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.
9. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated solid brass construction.

2.9 STAINLESS STEEL SINK – **P-4B**:

A. Sink Manufacturers:

1. Elkay Manufacturing Co.
2. Just Manufacturing Co.
3. Kindred
4. Advance Tabco

B. Faucet Manufacturers

1. Symmons
2. Delta Commercial
3. Chicago
4. Moen
5. Zurn

6. Kohler
 7. American Standard
- C. Top mounted self-rimming counter sink, 18 gauge; type 304 stainless steel with single control pull down kitchen faucet.
1. Basis of Design: Elkay DLR252210, 25"x22" outside dimensions and 21"x 15 ¾" inside dimensions.
 2. Bowl depth: 10 1/8".
 3. Three-hole punch, 4" on center.
 4. Sink Faucet: American Standard Portsmouth Model #4285.300.F15, single control faucet with pull down spray, 1.5 GPM, provide cover plate. Washerless ceramic disc valve cartridge with integral check valves, braided flexible supply hoses with 3/8" compression connectors. Memory position valving, lead free.
 5. Drain Opening: 3-1/2" off centered right location.
 6. P-trap: McGuire 912CB heavy cast brass adjustable body, with slip nut, with cleanout, box flange and seamless tubular wall bend.
 7. Drain: type 304 stainless grid drain
 8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.
 9. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated solid brass construction.

2.10 STAINLESS STEEL SINK – **P-4C** (ADA Accessible)

- A. Sink Manufacturers:
1. Elkay Manufacturing Co.
 2. Just Manufacturing Co.
 3. Kindred
 4. Advance Tabco
- B. Faucet Manufacturers
1. Symmons
 2. Delta Commercial
 3. Chicago
 4. Moen
 5. Zurn
 6. Kohler
 7. American Standard
- C. Top mounted self-rimming counter sink, 18 gauge, Type-304 stainless steel with pull down kitchen sink faucet.
1. Basis of Design: Elkay LRADQ2022, 19 ½"x22" outside dimensions and 16"x16" inside dimensions.

2. ADA bowl depth: 6 1/2".
3. Three-hole punch, 4" on center.
4. Sink Faucet: American Standard Portsmouth Model #4285.410.F15, single control faucet with pull down spray, 1.5 GPM, provide cover plate. Washerless ceramic disc valve cartridge with integral check valves, braided flexible supply hoses with 3/8" compression connectors. Memory position valving, lead free.
5. Drain Opening: 3-1/2" off centered right location.
6. P-trap: McGuire 912CB heavy cast brass adjustable body, with slip nut, with cleanout, box flange and seamless tubular wall bend.
7. Drain: type 304 stainless grid drain
8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.
9. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated solid brass construction.

2.11 STAINLESS STEEL SINK – **P-4D** (Same as P-4C except without pulldown spray on faucet).

2.12 STAINLESS STEEL SINK – **P-4E** (ADA Accessible)

A. Sink Manufacturers:

1. Elkay Manufacturing Co.
2. Just Manufacturing Co.
3. Kindred
4. Advance Tabco

B. Faucet Manufacturers

1. Symmons
2. Delta Commercial
3. Chicago
4. Moen
5. Zurn
6. Kohler
7. American Standard

C. Top mounted self-rimming deep counter sink, 18 gauge, type 304 stainless steel with two handled gooseneck faucet.

1. Basis of Design: Elkay LRADQ1522, 15"x22" outside dimensions and 11 1/2"x16" inside dimensions.
2. Bowl depth: 6 1/2".
3. Three-hole punch, 8" on center.
4. Sink Faucet: Chicago Faucet 1100-G2E3-317AB, deck mounted, 8" fixed centers, 5 1/4" swing gooseneck spout, 2.2 GPM, wrist blade handles.
5. Drain Opening: 3-1/2" centered.

6. P-trap: McGuire 912CB heavy cast brass adjustable body, with slip nut, with cleanout, box flange and seamless tubular wall bend.
7. Drain: type 304 stainless grid drain
8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.
9. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated solid brass construction.

2.13 STAINLESS STEEL SINK – **P-4F**

A. Sink Manufacturers:

1. Elkay Manufacturing Co.
2. Just Manufacturing Co.
3. Kindred
4. Advance Tabco

B. Faucet Manufacturers

1. Symmons
2. Delta Commercial
3. Chicago
4. Moen
5. Zurn
6. Kohler
7. American Standard

C. Top mounted self-rimming counter sink, 18 gauge, type 304 stainless steel with pull down kitchen sink faucet.

1. Basis of Design: Elkay DLR252210, 25"x22" outside dimensions and 21"x 15 3/4" inside dimensions.
2. Bowl depth: 10 1/8".
3. Three hole punch, 8" on center.
4. Sink Faucet: Chicago Faucet 1100-GN8AE3-317AB, deck mounted, 8" fixed centers, 8" swing gooseneck spout, 2.2 GP, wrist blade handles.
5. Drain Opening: 3-1/2" centered.
6. P-trap: McGuire 912CB heavy cast brass adjustable body, with slip nut, with cleanout, box flange and seamless tubular wall bend.
7. Drain: type 304 stainless grid drain
8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.
9. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated solid brass construction.

2.14 STAINLESS STEEL SINK – **P-4G**

A. Sink Manufacturers:

1. Elkay Manufacturing Co.
2. Just Manufacturing Co.
3. Kindred
4. Advance Tabco

B. Faucet Manufacturers

1. Symmons
2. Delta Commercial
3. Chicago
4. Moen
5. Zurn
6. Kohler
7. American Standard

C. Top mounted self-rimming deep counter sink, 18 gauge, type 304 stainless steel with two handled gooseneck faucet and solids interceptor.

1. Basis of Design: Elkay DLR252210, 25"x22" outside dimensions and 21"x 15 3/4" inside dimensions.
2. Bowl depth: 10 1/8".
3. Three hole punch, 8" on center.
4. Sink Faucet: American Standard Portsmouth Model #4285.300.F15, single control faucet with pull down spray, 1.5 GPM, provide cover plate. Washer-less ceramic disc valve cartridge with integral check valves, braided flexible supply hoses with 3/8" compression connectors. Memory position valving, lead free.
5. Drain Opening: 3-1/2" centered.
6. P-trap: McGuire 912CB heavy cast brass adjustable body, with slip nut, with cleanout, box flange and seamless tubular wall bend.
7. Drain: type 304 stainless grid drain
8. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges.
9. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated solid brass construction.
10. Solids Interceptor: Watts SI-742, floor mounted epoxy coated cast aluminum sediment interceptor with removable stainless steel sediment basket, gasketed cover and 2" threaded connections. Located under counter, allow 10" clearance above cover for sediment basket removal.

2.15 SHOWERS

A. Transfer Shower **P-5A** (ADA Accessible)

1. Basis of Design: Aquarius Model G3698BF; 40.5" x 39.5" x 82" outside dimensions. Inside dimensions: 36" x 36".
2. Material: Polyester gelcoat
3. Color: White.
4. Drain Location: Center.
5. Soap tray: molded in recessed.
6. ADA Seat: None
7. ADA Grab bars: smooth radius SS; 33.5"x18"x1.5" and 24"x1.5"
8. Curtain rod: 1" OD 18-gauge SS grommet style
9. Drain: Grid, NPS 2.
10. 3/4" threshold, with collapsible dam. Coordinate pit for shower to achieve a 1/2" or less threshold above finished floor.
11. Shower Faucets: Symmons Model BP-56-300-B30-V Temptrol II™ Shower System with Hand Spray. Pressure-balancing mixing valve with adjustable stop screw to limit handle turn. ADA compliant. Wall/hand shower with 5' flexible metal hose, in-line vacuum breaker, wall connection and flange. 30" slide bar for hand shower mounting. Provide modifications:
 - a. Suffix X: Integral service stops—allows water shut-off at valve for service
 - b. Suffix 1.5: 1.5 gpm flow rate

B. 36x36 Shower **P-5B**: Same as P-5A, less grab bars.

C. Transfer Shower Stall **P-5C** (ADA Accessible)

1. Basis of Design: Aquarius Model G 6233 BF .75; 62" x 33" x 78-3/4" outside dimensions. Inside dimensions: 30" x 60".
2. Material: Polyester gelcoat
3. Color: White.
4. Drain Location: Center.
5. Soap tray: molded in recessed.
6. ADA Grab bars: smooth radius SS; 36" x1.5" on back wall and 22"x1.5" on each side wall, mounted with stainless steel holds and secured from the rear with a 3"x3"x11 gauge metal mounting plate.
7. Seat: None
8. Curtain rod: 1" OD 18-gauge SS grommet style
9. Drain: Grid, NPS 2.
10. 3/4" threshold, with collapsible dam. Coordinate pit for shower to achieve a 1/2" or less threshold above finished floor.
11. Shower Faucets: Symmons Model BP-56-300-B30-V Temptrol II™ Shower System with Hand Spray. Pressure-balancing mixing valve with adjustable stop screw to limit handle turn. ADA compliant. Wall/hand shower with 5' flexible metal hose, in-line vacuum breaker, wall connection and flange. 30" slide bar for hand shower mounting. Provide modifications:
 - a. Suffix X: Integral service stops—allows water shut-off at valve for service
 - b. Suffix 1.5: 1.5 gpm flow rate

- D. Transfer Shower Stall **P-5D**: Same as P-5C, less seat and grab bars.

2.16 MOP SERVICE BASIN – **P-6**

- A. Manufacturers:

1. Zurn
2. Fiat
3. Mustee

- B. Install check valves at HW and CW connections.

- C. 24 x 24 x 10" H Molded Stone Mop Service Basin

1. Basis of Design: Zurn Z1996-24. Molded high density molded stone basin; PVC drain body, stainless steel strainer, and 3" gasketed outlet connection. Certifications: Meets ANSI Z124.6, CSA listed, and IAPMO listed under file # 3561.
2. Wall Guard (-WG) Provide 20 gage type 304 stainless steel bumpers used to protect walls adjacent to mop basin. Two panels shall be supplied for corner installation
3. Mop holder (-MH): Stainless steel 24" long x 3" wide with three rubber tool grips
4. Bumper Guards (-BS) Provide 20 gage type 304 stainless steel bumper guards to protect top edge of basin.

- D. Chicago Faucets No. 540-LD897SWXFABCP, wall mounted. 8" fixed centers, Hot and cold water sink faucet, chrome plated solid brass construction. 5 3/4" center to center rigid vacuum breaker spout with 3/4" male hose thread and pail hook. 2 3/8" metal lever handles with eight point tapered broach and secured blue and red buttons. Quarter-turn re-buildable compression cartridge, opens and closes 90°, closes with water pressure, features square tapered stem. Straight 2" inlet supply arm with wall flange with 1/2" NPT female thread inlet. Provide atmospheric vacuum breaker. ECAST® construction with less than 0.25% lead content by weighted average. Provide per ADA ANSI/ICC A117.1 requirements and shall be tested and certified to industry standards: ASME A112.18.1/CSA B125.1, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, and NSF/ANSI 372 Low Lead Content.

2.17 SALON SHAMPOO SINK – **P-7**

- A. Sink provided as part of the furniture package. Plumbing contractor shall rough in and install.

- B. Provide a hair interceptor: Watts Drainage SI-750-TO chrome plated cast iron hair interceptor with gasketed cover, slip joint inlet elbow, removable stainless steel sediment basket, and IPS threaded connections.

2.18 EMERGENCY EYEWASH / DRENCH HOSE – **EW-1**

- A. Guardian Model G5026BP-FSH-VB-TMV dual-purpose eyewash/drench hose for wall mounting. Unit meets the provisions of ANSI Z358.1-2009 as both an eyewash and a drench hose. Unit may be left in the mounting bracket for use as a fixed eyewash, leaving user's hands

free. Alternatively, unit may be removed for use as a drench hose to rinse any part of user's eyes, face or body.

- B. Spray Head Assembly: Two GS-Plus spray heads mounted side-by-side. Each head has a "flip top" dust cover, internal flow control and filter to remove impurities from the water flow.
- C. Valve: Forged brass squeeze valve activated by stainless steel lever handle. Valve has replaceable stainless steel seat for exceptional durability. Locking clip engages when handle is depressed, providing "hands free" operation. Valve stays open until locking clip is released.
- D. Mounting: Bracket with spring clips to hold unit on wall. Clips position spray heads and handle to face forward at all times.
- E. Backflow Preventer: In-line dual check backflow preventer installed on inlet of hose.
- F. Supply: 3/8" NPT male swivel-type inlet.
- G. Sign: ANSI-compliant identification sign.
- H. Quality Assurance: Unit shall be completely assembled and water tested prior to shipment.
- I. Provide Options:
 - 1. FSH 8 ft. flexible stainless steel hose in place of PVC hose.
 - 2. VB In-line vacuum breaker for installation between valve and spray head.
 - 3. TMV G3600 thermostatic mixing valve precisely blends hot and cold water to deliver warm (tepid) water as provided by ANSI Z358.1-2009.

2.19 BOTTLE FILLING STATION - **BFS-1**

- A. Manufacturers
 - 1. Halsey Taylor.
 - 2. Elkay Manufacturing Co.
 - 3. Haws Corporation.
 - 4. Oasis Corporation.
 - 5. Sunroc Corp.
- B. Basis of Design: Elkay Model EMASM – Surface-mount bottle filling station designed for installations without the need for electricity. Bottle filler shall provide 1.0 gpm flow rate with laminar flow to minimize splashing. Shall include integrated silver ion antimicrobial protection in key areas. Unit shall meet ADA guidelines. Unit shall be a Lead-free design which is certified to NSF/ANSI 61 and 372 and meets Federal and State low-lead requirements.
 - 1. Complete mechanical activation and function. No electrical connection required.
 - 2. Quick Fill Rate of 1 gallon per minute.
 - 3. Integrated Silver Ion Anti-microbial Protection in key areas.
 - 4. Laminar Flow provides minimal splash.
 - 5. Real Drain System eliminates standing water.
 - 6. No bubbler required.
 - 7. Stainless steel bottle filler wrapper with ABS plastic alcove.

8. Includes robust hanging bracket for surface mount. Mounting height per architectural elevations.

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 - GENERAL

- A. Assemble and support fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- C. 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.
- D. Install traps on fixture outlets as required.
- E. 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 Division 22 Section "Common Work Results for Plumbing" for escutcheons.
- F. Set bathtubs, shower receptors, and mop service basins in leveling bed of cement grout. Refer to Division 22 Section "Common Work Results for Plumbing" for grout.
- G. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.3 WATER CLOSETS AND URINALS

- A. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

3.4 SINKS AND LAVATORIES

- A. 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.

3.5 FOOD SERVICE FIXTURES

- A. Foodservice Equipment: Provide rough-in piping, traps, tailpieces, indirect waste lines and make final and necessary connections for foodservice equipment. Install faucets, spray units, drains, lever drains, vacuum breakers, solenoid valves, check valves, flow control valves, water inlet fittings, filters, strainers, pressure reducing valves and gas valves furnished by foodservice equipment contractor. Provide condensate drain piping from cooler and freezer evaporators. Make all final and necessary plumbing connections.
- B. Stubs for equipment should come out of walls wherever possible.
- C. All connecting piping should be neatly assembled by the Plumbing Contractor up away from the floor at least 12" and with a minimum of exposed horizontal runs that are difficult to clean.
- D. Care should be taken to specify that piping shall be run in a sanitary manner, off the floor.

3.6 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.
- C. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- D. Provide plumbing hookups to Fixtures and Equipment Specified in Section 11 31 00 "Residential Appliances". Connect fixtures and equipment with water supplies Use size fittings required to match fixtures and equipment. Connect to plumbing piping.
- E. Residential Dishwasher: When the sink is equipped with a garbage disposal unit, the dishwasher waster shall be connected to the inlet side of the disposal after passing through the required air gap fitting. When the sink is not equipped with a garbage disposal unit, the dishwasher waste shall be connected to the continuous waste of the sink using a wye-branch fitting, after passing through the required air gap fitting. The wye branch fitting may be installed in any vertical section of the continuous waste on the inlet side of the trap. The wye branch fitting shall not be installed in a horizontal run.

3.7 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.
- E. Water-Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- F. Install fresh batteries in sensor-operated mechanisms.

3.8 ADJUSTING

- A. Operate and adjust fixtures. Replace damaged and malfunctioning fixtures.
- B. Adjust water pressure to produce proper flow and stream.
- C. Emergency plumbing fixtures: adjust to approximately 85°F temperature.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Water coolers: Adjust fixture flow regulators for proper flow and stream height. Adjust water-cooler temperature settings.

3.9 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures and other fittings with manufacturers' recommended cleaning methods and materials. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts. Remove sediment and debris from drains.
- C. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

3.10 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless allowed in Division 1.

END OF SECTION 22 40 00

SECTION 23 05 00 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to Division 21, 22, & 23 sections.

1.2 GENERAL

- A. This Section includes mechanical items common to all of this division specification sections.
- B. Provide services, skilled and common labor, and all apparatus and materials required for the complete installation as shown and within the intent of the contract documents, field conditions, and code requirements.
- C. The intention of these Contract Documents is to call for finished work, fully tested and ready for operation. Any components or labor not mentioned in the Contract Documents but required for functioning systems shall be provided. Should there appear to be any discrepancies or questions of intent, the Contractor shall refer the matter to the Architect/Engineer for decision before start of any related work.
- D. The drawings show the general arrangement of systems and equipment but do not show all required fittings and offsets that may be necessary to connect pipes and ductwork to equipment, and to coordinate with other trades. Provide all necessary fittings, offsets and runs based on field measurements and at no additional cost. Coordinate with other trades for space available and relative location of equipment and accessories. Pipe and duct location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- E. This contractor will be responsible to carry out the commissioning requirements specified. Refer to Division 1 for additional requirements.

1.3 EFFICIENCY MAINE

- A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.
- B. The contractor shall also:
 - 1. Become familiar with the Efficiency Maine Business Program including available incentives and the application and review process.

2. Review plans and specifications for compliance with Efficiency Maine standards for applicable systems and technologies.
 3. Review plans and specifications for any and all incentive opportunities, prescriptive and custom.
- C. The project schedule shall reflect and accommodate the time required to achieve application preapproval from EM. No equipment shall be purchased until preapproval is received from EM.
- D. All invoices shall be forwarded to EM within 60 days of the completion of work. This deliverable shall be shown on the project schedule as a milestone date and coordinated with all contractors to assure compliance with this requirement.
- E. Efficiency Maine is available to assist in the application process and can be reached at 866-376-2463. Contractor must contact EM prior to submittals to review the project equipment and scope. As a minimum, obtain rebates for the following:
1. Split heat pumps
 2. Multi split heat pumps
 3. VFD's
 4. RTU's
 5. Boilers

1.4 DEFINITIONS

- A. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- B. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- C. "Provide": Furnish and install, complete and ready for the intended use.
- D. "Shall": The word shall is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and procedures and from which no deviation is permitted.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and attics.
- F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- G. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- H. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

- I. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

1.5 SUBMITTALS

- A. Provide in accordance with Division 1 of the specifications.

1.6 SUBSTITUTIONS

- A. Provide in accordance with Division 1 of the specifications.

1.7 QUALITY ASSURANCE

- A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.
- B. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- D. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Comply with provisions in ASME B31 Series, "Code for Pressure Piping." Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- E. Electrical Characteristics for Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- F. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- G. Plumbing work shall be performed by, or under, the direct supervision of a licensed master plumber.
- H. Electrical work shall be performed by, or under, the direct supervision of a licensed electrician.
- I. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Provide in accordance with Division 1 - Product Requirements.
- B. Piping:
 1. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
 2. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor.
 3. Protect fittings, flanges, and piping specialties from moisture and dirt.
 4. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

- A. Coordinate use of project space and sequence of installation of mechanical and electrical work, which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- B. Coordinate use of project space and sequence of installation of work.
- C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels and doors are specified in Division 8.

1.10 TEST ADJUST AND BALANCE READINESS

- A. The Contractor shall provide and coordinate the services of qualified, responsible sub-contractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting, and balancing period.

- B. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate the systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB.
- C. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The Contractor shall allow adequate time for the testing and balancing activities of the Owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.
- D. The Drawings and Specifications indicate valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB Firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.
- E. Complete operational readiness of the HVAC systems also requires that the following be accomplished:
 - 1. Distribution Systems:
 - a. Verify installation for conformity to design. All supply, return, and exhaust ducts shall be terminated and tested as required by the Specification.
 - b. Dampers shall be properly located and functional. Dampers shall have tight closure and open fully with smooth and free operation.
 - c. Supply, return, exhaust, and transfer grilles, registers, diffusers, and terminal devices shall be installed and secured in a full open position.
 - d. Air handling systems, units, and associated apparatus shall be sealed to eliminate uncontrolled bypass or leakage of air. Final clean filters shall be in place, coils shall be clean with fins straightened, bearings properly greased, and the system shall be completely operational. The Contractor shall verify that all systems are operating within the design pressure limits of the piping and ductwork.
 - e. Under normal operating conditions, check condensate drains for proper connections and functioning. Cooling coil drain pans have a positive slope to drain. Cooling coil condensate drain trap maintains an air seal.
 - f. Check for proper sealing of air-handling unit components.
 - g. Fans shall be operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating, as per the starter manufacturer; record motor amperage and voltage on each phase at start-up, and verify they do not exceed nameplate ratings.
 - h. Thermal overload protection is in place for fans and other equipment. Bearings shall be greased. Belts shall be aligned and tight
 - i. Terminal units shall be installed and functional (i.e. controls functioning).
 - 2. Water Circulating Systems:
 - a. Verify installation for conformity to design. Hydronic systems are pressure tested, flushed, filled, and properly vented. Service and balance valves are fully open. Examine HVAC system and equipment installations to verify that indicated balancing devices are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation

- b. All valves shall be set to their full open position. After the system is flushed and checked for proper operation, all strainers shall be removed and cleaned. The Contractor shall repeat the operation until circulating water is clean and then the start-up strainers shall be discarded. Bearings shall be greased.
 - c. Record pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating. Verify that the electrical heater elements are of the proper size and rating as per the starter manufacturer.
 - d. In preparation of TAB, water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Chemicals shall be added to closed systems to treat piping and inhibit corrosion. The system static pressure shall be adequate to completely fill the system without operating the pumps.
 - e. Check and set operating parameters of the heat transfer and control devices to the design requirements.
 - f. Proper balancing devices shall be in place and located correctly. These devices include but are not limited to flow meters, pressure taps, thermometer wells, balancing valves, etc. Heat transfer coils shall be checked for correct piping connections.
3. Automatic Controls
- a. The BAS shall verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.
 - b. The BAS Contractor shall verify that all controlling instruments are calibrated and set for design operating conditions with the exception of components that require input from the TAB Agency, but a default shall be set. The Control Contractor shall cooperate with the TAB Agency and provide all software and interfaces to communicate with the system.
 - c. The BAS Contractor shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB Agency that the BAS is operational. The BAS Contractor shall provide technical support (technicians and necessary computers) to the TAB Agency for a complete check of these systems.
 - d. Prior to occupancy, each ventilation system shall be tested to ensure that OA dampers operate properly in accordance with system design.
 - e. Fire Alarm: Division 26 shall thoroughly check all detection devices, sequences, inter-locks, etc. before notifying the TAB Agency that the system is operational. Division 26 shall certify that the systems are totally operational to the Contractor prior to the TAB beginning.

1.11 RENOVATION PROJECTS

- A. Project Conditions: Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner to minimize conflicts with the Owner's operations.
- B. The Contractor shall study all drawings and specifications, visit the site, and get acquainted with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to be familiarized with the conditions and extent of the proposed work. The Contractor shall execute all alterations, additions, removals, relocations or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the drawing and specifications.
- C. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.

- D. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize use of driveways and entrances. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- E. Follow the recommended procedures of the SMACNA IAQ Guidelines for Occupied Buildings under Construction.
1. Dust partitions and depressurization of the work are performed under Division 1.
 2. The return side of an HVAC system is, by definition, under negative pressure and thus capable of drawing in nearby construction dust and odor. When possible, the entire system shall be shut down during heavy construction or demolition. The system shall be isolated from the surrounding environment as much as possible (e.g., all tiles in place for a ceiling plenum, duct and air handler leaks repaired) to prevent induction of pollutants.
 3. Return system openings in (and immediately adjacent to) the construction area shall be sealed with plastic.
 4. When the system must remain operational during construction, temporary filters shall be added to return grilles. All filters must receive frequent periodic maintenance and be replaced at end of project.
 5. When the general system must remain operational, the heaviest work areas shall be dampered off or otherwise blocked if temporary imbalance of the return air system does not create a greater problem.
 6. The mechanical room shall not be used to store construction or waste materials.
 7. Diffusers, VAV boxes, and ducts may be adequately protected in most cases where the above measures are implemented. When the system is off for the duration of construction, diffusers shall also be sealed in plastic for further protection. Ducts, diffusers, and window units shall be inspected upon completion of the work for the amount of deposited particulate present and cleaned where needed. If significant dust deposits are observed in the system during construction, some particulate discharge can be expected during start-up. When such a discharge is only minor, delaying re-occupancy long enough to clean up the dust may be sufficient. In more severe cases, installing temporary coarse filters on diffusers or cleaning the ducts may be necessary. The condition of the main filters shall be checked whenever visible particulates are discharged from the system.
- F. Continuity of Services: The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary plumbing and mechanical and electrical connections and relocations as required to accomplish the above.
- G. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services. Notify Owner at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions. Indicate method of providing temporary utilities. Do not proceed with utility interruptions without Owner's written permission.

PART 2 - PRODUCT

2.1 PRODUCT CRITERIA

- A. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
- B. Equipment Service: Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.
- C. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- D. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- E. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
- F. Asbestos products or equipment or materials containing asbestos shall not be used.

2.2 PIPE JOINING MATERIALS

- A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods. Refer to individual piping Sections for special joining materials not listed below.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- E. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.
- F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

- G. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- H. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAgl, silver alloy for refrigerant piping, unless otherwise indicated.
- I. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- J. Solvent Cements for Joining Plastic Piping: CPVC Piping: ASTM F 493. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve; ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.4 DIELECTRIC FITTINGS

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. Fittings shall match piping specifications. Threaded dielectric union, ANSI B16.39. Watts Series LF3000 (lead free) or approved equal. Flange union with dielectric gasket and bolt sleeves, ANSI B16.42. Dielectric flange fittings: Watts Series LF3100.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve; Thunderline Link-Seal, or approved equal.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Glass-reinforced nylon.
 - 3. Connecting Bolts and Nuts: Stainless steel, of length required to secure pressure plates to sealing elements.

2.6 ESCUTCHEONS

- A. Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated. Metals and finish shall conform to ASME A112.19.2. Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. ID shall closely fit around pipe, tube, and insulation of insulated piping and an OD that completely cover the opening.
- B. All escutcheons shall have setscrews for maintaining a fixed position against a surface.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout. Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications. Design Mix: 5000-psi, 28-day compressive strength. Packaging: Premixed and factory packaged.

2.8 ROOFING

- A. Provide curbs, supports, and components in accordance with Division 7.

2.9 MOTORS

A. Motor Characteristics

1. Motors 1/2 HP and Larger: Three phase.
2. Motors smaller than 1/2 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
5. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.
6. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
7. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
8. Enclosure: as specified.

B. Polyphase Motors

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium efficiency ratings shall meet or exceed the NEMA Premium qualifying efficiencies. Efficiencies shall be eligible for utility rebates. For example, 1800-RPM ODP minimum required efficiency for a 7.5 HP motor is 91.0%
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors shall have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.

5. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.
8. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Single-Phase Motors

1. Type: One of the following, to suit starting torque and requirements of specific motor application: Permanent-split capacitor, Split-phase start, capacitor run, Capacitor start, capacitor run.
2. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
3. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
4. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

D. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Provide AEGIS® Shaft Grounding Ring (SGR) on either DE or NDE of motor to divert current away from the bearings and protect bearings in attached equipment.
2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
3. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
4. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
5. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.10 VIBRATION ISOLATION

- A. All equipment shall be isolated to prevent vibration transmission to the building structure.

PART 3 - EXECUTION

3.1 DEMOLITION AND REMOVALS

- A. Refer to Division 1 for general demolition requirements and procedures.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 COMMON REQUIREMENTS

- A. Install piping, ductwork, and equipment to allow maximum possible headroom unless specific mounting heights are indicated. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- C. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- D. Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced so as to be left in safe structural condition in accordance with the local building code requirements.
- E. Install piping and ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- G. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.
- H. Install piping to permit valve servicing.
- I. Install equipment and other components to allow right of way for piping installed at required slope.
- J. Install free of sags and bends.
- K. Provide unions or flanges at connections to equipment.
- L. Install fittings for changes in direction and branch connections.

- M. Make allowances for application of insulation.
- N. Select system components with pressure rating equal to or greater than system operating pressure.
- O. Verify final equipment locations for roughing-in.
- P. Protection and Cleaning: Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items shall be replaced. Protect all finished parts of equipment. Close duct and pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and the relevant specification section specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8. Only brazing alloys having a liquid temperature above 1000°F shall be used.
- 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: Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Non-pressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPE PENETRATIONS

A. Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed.

B. Refer to Section 23 07 00 "Mechanical Insulation".

C. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation.

D. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install steel pipe sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
4. Sleeves are not required in drywall construction.
5. Sleeves are not required for core-drilled holes. Piping through concrete or masonry shall not be subject to any load from the building construction.

E. To prevent accidental liquid spills from passing to a lower level, provide the following:

1. For sleeves: Extend sleeve 1-1/2 inch above finished floor and provide sealant for watertight joint.
2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

F. Exterior-Wall Pipe Penetrations:

1. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
2. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

G. Escutcheons: Provide for penetrations in finished spaces where pipes are exposed.

- H. Plastic and copper piping penetrating framing members, and within one-inch of the framing, shall be protected with 10-gauge steel nailing plates. The steel plate shall extend along the framing member a minimum of 1.5" beyond the OD of the pipe or tubing.

3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated: Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment. Install flanges or Victaulic couplings, in piping NPS 2-1/2 and larger, adjacent to flanged or grooved-ended valves and at final connection to each piece of equipment. Provide dielectric fittings at connection between copper and ferrous metal.
- B. Swing Connections for Expansion: Connect risers and branch connections to mains with at least five pipe fittings, including tee in main. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.7 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Provide in accordance with Division 5.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor materials and equipment. Field Welding: Comply with AWS D1.1.

3.9 FIRESTOPPING

- A. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Division 7 for materials. Seal all penetrations through fire-or smoke-rated wall, partition, ceiling, or roof

assemblies with firestopping system. Refer to Architectural plans for location of rated assemblies. Refer to Division 7 for firestopping systems.

3.10 PAINTING

- A. Painting of plumbing and mechanical systems, equipment, and components is specified in Division 9.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.11 CONCRETE HOUSEKEEPING PADS

- A. Provide in accordance with Division 3. See detail on Sheet S2.1.
- B. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Construct concrete bases not less than 4 inches larger in both directions than supported unit.
- C. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors.
- D. **Provide** 4" high (+/-) housekeeping pads for the following:
 - 1. Boilers
 - 2. Base Mounted Pumps
 - 3. Domestic Water Booster Pumps
 - 4. Indirect water heaters
 - 5. Fire pump
 - 6. Fire pump fuel tank
 - 7. Expansion Tanks
 - 8. As noted on plans
 - 9. As recommended by Equipment manufacturer.
- E. Exterior Pads: Below the equipment pad: Provide 8" deep compacted gravel base to 95% proctor. Remove all organic material prior to placing the gravel. Compacted gravel area; minimum dimensions: Pad length plus 12"; Pad width plus 12". Bolt equipment to pads with galvanized or SS fasteners.

3.12 ROOFING

- A. Provide in accordance with Division 7.
- B. Provide roof curbs, equipment supports, and roof penetrations.
- C. Exterior fasteners used for fastening equipment to curbs and sleepers shall be galvanized or SS.

3.13 PROJECT CLOSEOUT

- A. Provide Demonstration and Training in accordance Division 1.
- B. Provide Project Record Documents in accordance with Division 1.
- C. Follow Closeout procedures as per Division 1.
- D. Provide Operation and Maintenance information in accordance with Division 1.

END OF SECTION 23 05 00

SECTION 23 05 16 – BRAIDED EXPANSION LOOPS AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 23 Section “Common Work Results for Mechanical”

1.2 SUMMARY

- A. This Section includes braided pipe expansion loops.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products suitable for piping system fluids, materials, working pressures, and temperatures.

1.4 SUBMITTALS

- A. Product Data: For each type of expansion fitting indicated.
- B. Schedule: Indicate manufacturer's number, size, location, and features for each expansion fitting and loop.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Metraflex Co.
 - 2. Flex Hose Co., Inc.
 - 3. Flexicraft

2.2 BRAIDED EXPANSION LOOPS

- A. Provide flexible expansion loops of size and type noted on drawings; Metraflex Metraloop expansion joints, or approved equal. Flexible loops shall consist of two flexible sections of hose and braid, two 90° elbows, and a 180° return assembled in such a way that the piping does not

change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180° return, and a drain/air release plug.

- B. Flexible loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application.
- C. Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings.
- D. Size for 4" end-to-end movement.

2.3 ANCHORS

- A. Metraflex Model PA anchor clamp, or approved equal. Provide light weight anchor for low load; compatible with braided expansion loop manufactures recommendations for "no thrust" expansion joints. Clamps to pipe.

2.4 GUIDES

- A. Metraflex Model PGIV shall be of the radial type employing a heavy wall guide cylinder with weld down or bolt down anchor base. A two section guide spider, having 1/8" maximum diametrical clearance with guide cylinder inside diameter, bolted or welded tight to the carrier pipe which slides through the guide cylinder I.D. Cylinder shall be of sufficient size to clear pipe insulation and long enough to prevent over travel of the spider.

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head; ASTM F 844, steel, plain, flat washers.
- C. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application. Stud: Threaded, zinc-coated carbon steel. Expansion Plug: Zinc-coated steel. Washer and Nut: Zinc-coated steel.
- D. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application. Bonding Material: ASTM C 881, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated; Washer and Nut: Zinc-coated steel.
- E. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

PART 3 - EXECUTION

3.1 BRAIDED EXPANSION LOOP INSTALLATION

- A. Install expansion fittings according to manufacturer's written instructions.
- B. Install expansion fittings in sizes matching pipe size in which they are installed.
- C. Align expansion fittings to avoid end-loading and torsional stress.
- D. Loops can be installed in a neutral, pre-compressed or pre-extended condition as required for the application.
- E. A pipe guide shall be installed anywhere within 15 pipe diameters on each side of the braided expansion loop. Loops anchored on one side need only one guide on the traveling side. Attach guides to pipe and secure to building structure.
- F. Install pipe anchors according to expansion fitting manufacturer's written instructions.
 - 1. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
 - 2. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 3. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install guides on each side of pipe expansion fittings and loops as recommended by manufacturer.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.

2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16

SECTION 23 05 19 – THERMOMETERS AND PRESSURE GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section “Common Work Results for Mechanical”
 - 2. Mechanical equipment Sections that specify meters and gauges as part of factory-fabricated equipment.

1.2 SUMMARY

- A. This Section includes thermometers and pressure gauges.

1.3 ACTION SUBMITTALS

- A. Product Data: Include scale range, ratings, and calibrated performance curves for each gauge, fitting, specialty, and accessory specified.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ashcroft
 - 2. Weksler
 - 3. Ernst Gauge Co.
 - 4. Trerice: H. O. Trerice Co.
 - 5. Weiss Instruments, Inc.

2.2 THERMOMETERS

- A. Liquid-In-Glass Industrial Thermometers: shall be a blue reading (Fill Type Spirit: Blue colored, organic) liquid-in-glass adjustable angle type, 9" scale, cast aluminum case with cured polyester powder coating, clear acrylic window and brass separable thermowell. Thermometers will be Terice BX9 Series or approved equal.
- B. Scale Range: Temperature ranges for services listed are as follows: The proper range will be selected so that the operating temperature of the material being measured will fall approximately in the middle of the scale.
1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
 2. Domestic Cold Water: 0 to 100°F, with 1°F scale divisions.
 3. Heating Hot Water: 30 to 180°F, with 2°F scale divisions.
- C. Thermowells: Provide fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
1. Material: Brass, for use in copper piping.
 2. Material: Stainless steel, for use in steel piping.
 3. Where insulation thickness exceeds 2", a longer stem thermometer will be used with an extension neck brass separable thermowell. The extension neck will be at least 2" long.
 4. Thermometers for measuring fluid temperatures will have stems with insertion lengths of roughly half of the pipe diameter; minimum insertion length will be 2".
 5. Cap: Threaded, with chain permanently fastened to socket. Heat-Transfer Fluid: Mixture of graphite and glycerin.

2.3 PRESSURE GAUGES

- A. Pressure gauges shall be 3½" dial size with a flangeless cast aluminum case, stainless steel friction ring and glass window. Movement will be brass with a bronze bourdon tube and brass socket. Dial face will be white with black figures; pointer will be friction adjustable type. Accuracy shall be ±1% of scale range, ASME B40.1 Grade 1A. Pressure gauges will be Terice No. 600CB approved equal.
1. Connector: Brass, NPT 1/4.
 2. Units of Measure: PSI
 3. Provide silicone-damped movement.
 4. Range: The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.
 5. Install pressure-gauge needle valve and snubber (Terice No. 872 pressure snubbers) in piping to pressure gauges; ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.
 6. Needle Valves: Terice 735 Series; NPS 1/4 brass or 316 stainless steel needle type.

- B. Scale Range: Pressure ranges for services listed are as follows: The proper range will be selected so that the operating pressure of the material being measured will fall approximately in the middle of the scale.
 - 1. Domestic Hot Water: 0 to 100 psi
 - 2. Domestic Cold Water: 0 to 100 psi.
 - 3. Heating Hot Water: 0 to 60 psi.

2.4 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. Peterson Equipment Co., Inc.
 - 3. Trerice, H. O. Co.
 - 4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 5. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 GAUGE INSTALLATION, GENERAL

- A. Install according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install thermowells with extension on insulated piping.
- C. Install separable sockets in vertical position in piping tees.

3.3 PRESSURE-GAUGE INSTALLATION

- A. Install pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position.
- B. Install valve and snubber in piping for each pressure gage for fluids (except steam).

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties. Install adjacent to machines and equipment to allow service and maintenance. Connect per manufacturers recommendations.

3.5 ADJUSTING AND CLEANING

- A. Calibrate according to manufacturer's written instructions, after installation.
- B. Adjust faces to proper angle for best visibility.
- C. Clean windows and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 23 05 19

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for Mechanical"
 - 2. Division 23 Section "Mechanical Insulation"
 - 3. Division 23 Section "Ductwork"

1.2 SUMMARY

- A. This Section includes hangers and supports for piping and equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.

- C. Delegated-Design Submittal: For trapeze hangers 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. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.
 - 3. Welded steel support designs

1.5 QUALITY ASSURANCE

- A. Install in accordance with MSS SP69 - Manufacturers Standardization Society: Pipe Hangers and Supports- Selection and Application
- B. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
- C. Pipe Hangers, Supports, and Components: The materials of all pipe hanging and supporting elements shall be in accordance with MSS SP-58.
- D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Carpenter & Patterson, Inc.
 - 3. Grinnell Corp.
 - 4. Hubbard Enterprises/Holdrite®
 - 5. National Pipe Hanger Corp.
 - 6. Piping Technology & Products, Inc.
 - 7. Unistrut
 - 8. Anvil International, Inc.
 - 9. Empire

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS (“UNISTRUT”)

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.
 - b. Flex-Strut Inc.
 - c. Thomas & Betts Corporation.
 - d. Unistrut Corporation; Tyco International, Ltd.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Unistrut Perma-green or similar.

2.5 THERMAL-HANGER SHIELD INSERTS

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

1. Carpenter & Paterson, Inc.
2. ERICO International Corporation.
3. National Pipe Hanger Corporation.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Piping Technology & Products, Inc.
6. Value Engineered Products, Inc.
7. Buckaroos, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. Shields: G90 galvanized steel.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 ACCESSORY PRODUCTS

- A. Vertical Mid-Span Piping Supports: For use with vertically-installed pipe, NPS 4 (DN 100) and smaller, for a distance exceeding 48 inches (1.2 m). Subject to compliance with requirements, provide Holdrite; HOLDRITE Stout Bracket System, or equal.
- B. Equipment Supports: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
- C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

- C. Metal Framing System Installation: Provide per manufactures recommendations and calculations.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Provide per manufactures recommendations and calculations.
 - 2. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 3. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by plumbing code and ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

- b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
- H. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- I. Use padded hangers for piping that is subject to scratching.
- J. Use thermal-hanger shield inserts for insulated piping and tubing.

- K. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 and larger.
 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 and larger if no insulation is required.
 3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 1.
 4. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 and larger.
 6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 7. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 and larger if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 and larger, from two rods if longitudinal movement caused by expansion and contraction might occur.
- L. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 and larger.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 and larger if longer ends are required for riser clamps.
- M. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel weld-less Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 9. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 10. Side-Beam Brackets (MSS Type 34): For sides of beams.
 11. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- O. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.7 HANGER SPACING

- A. Support piping and tubing not listed below according to MSS SP-69 and manufacturer's written instructions.
- B. Boiler Piping Supports (State of Maine Fuel Board Rules)
1. NPS 1/2": Maximum span, 6 feet; minimum rod size, 3/8 inch.
 2. NPS 3/4 to 1: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/4: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 6. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 8. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- C. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod sizes:
1. NPS 3/4 to 1-1/4": Maximum span, 7 feet; minimum rod size, 3/8 inch.

2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
 5. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 6. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- D. Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:
1. NPS 1/2 and 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2 to 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.
 6. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 7. NPS 4: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 8. Maximum vertical steel and copper pipe attachment spacing: 10 feet.
- E. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non-adhesive isolation tape- B-Line Iso-pipe. Galvanized felt isolators sized for copper tubing may also be used, B-Line B3195CT.
- F. Piping Hangers for Plastic Piping:
1. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
 2. In systems where large fluctuations in temperature occur, allowances must be made for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow for expansion and contraction, hangers must be placed so as not to restrict this movement.
 3. Hangers shall not compress, distort, cut or abrade the piping. All piping shall be supported at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal. Pipe should also be supported at all branch ends and at all changes of direction.
 4. Install hangers for piping with the following maximum horizontal spacing and minimum rod diameters (pipe temperature 100°F or lower).
 - a. NPS 1 and smaller: 4 feet with 3/8-inch rod.
 - b. NPS 1-1/4 and 1-1/2 and NPS 2: 5 feet with 3/8-inch rod.
 - c. NPS 3: 6 feet with 1/2-inch rod.
 - d. NPS 4: 6.5 feet with 5/8-inch rod.
 - e. NPS 6 and 8: 8 feet with 3/4-inch rod.
 5. Install supports for vertical piping every 10 feet.
- G. Support vertical piping independently of connected horizontal piping. Support vertical pipes at base and at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- H. Place a hanger within 12 inches of each horizontal elbow.

END OF SECTION 23 05 29

SECTION 23 05 48 - MECHANICAL SEISMIC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Common Work Results for HVAC".
 - 3. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.

1.2 SUMMARY

- A. It is the intent of the seismic portion of this specification to keep building system components in place during a seismic event.
- B. All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.
- C. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements.
- D. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.3 SCOPE

- A. The work in this section includes, but is not limited to the following:
 - 1. Seismic restraints for fuel gas piping.

1.4 PERFORMANCE REQUIREMENTS

- A. Manufacturer of seismic control equipment shall have the following responsibilities:
 - 1. Determine seismic restraint sizes and locations.
 - 2. Provide seismic restraints as scheduled or specified.

3. Provide calculations and materials if required for restraint of un-isolated equipment.
 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
- B. Seismic restraints shall be designed in accordance with seismic force levels as detailed herein.
- C. Applicable Code: IBC-2009.
- D. Seismic Site Class: See structural plan S0.0.
- E. Design Spectral Response at Short Periods (SDS): See structural plan S0.0.
- F. Short Period Spectral Response Acceleration (SS): See structural plan S0.0.
- G. Building Use Group or Occupancy Category: See structural plan S0.0.
- H. Equipment Schedule: The following list indicates individual equipment importance factors, $I_p=1.5$:
1. Natural gas piping

1.5 SUBMITTALS

- A. The manufacturer of seismic restraints shall provide submittals for products as follows:
1. Catalog cuts or data sheets on specific restraints detailing compliance with the specification.
 2. Detailed schedules of flexible and rigidly mounted equipment, showing seismic restraints by referencing numbered descriptive drawings.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:
1. Design Calculations: Calculate requirements for selecting seismic restraints.
 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 3. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
 4. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.
- C. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

- A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

1.7 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

- A. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, Type SCBH between the hanger rod nut and the clevis or Type SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.
- B. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be Type SSB as manufactured by Mason Industries, Inc.
- C. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R"

Number from OSHPD in the State of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.

- D. Note: seismic cable restraints, seismic solid braces, and steel angles above apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze.
- E. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California. Clevis cross brace shall be Type CCB as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- B. All mechanical equipment shall be vibration isolated and seismically restrained as specified.
- C. Installation of seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.
- D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.

- H. Correct, at no additional cost, all installations that are deemed defective in workmanship and materials at the contractor's expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
 - 1. Flanges of structural beams.
 - 2. Upper truss cords in bar joist construction.
 - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- J. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, piping or conduit. Cable assemblies shall be installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.
 - 1. The support rods must be braced when necessary to accept compressive loads with steel angles and rod clamp assemblies.
 - 2. At all locations where restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with pipe clevis cross bolt braces.

3.3 SEISMIC RESTRAINT OF PIPING

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."
- B. Piping shall be provided with seismic restraints in accordance with Seismic Restraint Manual – Guidelines for Mechanical Systems dated 1998, as published by SMACNA.
 - 1. Seismically restrain the following piping.
 - a. Natural gas piping that is 1" I.D. or larger.
 - 2. Piping exclusions:
 - a. Gas piping less than 1" inside diameter.
 - b. All piping suspended by individual hangers 12" or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" limit is exceeded by any hanger in the run, seismic bracing is required for the run.
 - c. The 12" exemption applies for trapeze-supported systems if the top of each item supported by the trapeze qualifies.
 - 3. Transverse piping restraints shall be at 20' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - 4. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - 5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or tee or combined stresses are within allowable limits at longer distances.

6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.

3.4 ADJUSTING

- A. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Valve numbering scheme. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Markers: Engraved, color-coded laminated plastic; attach with screws or contact-type, permanent adhesive. Size: 2-1/2" x 1" or as applicable.

1. Terminology: Match schedules as closely as possible.
 2. Data: Name and plan number, equipment service, design capacity, and other design parameters such as pressure drop, entering and leaving conditions, and speed.
- B. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Seton, Brady, or approved equal; preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length. Size of letters and length of color field per ASME A13.1.
 3. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location.
 4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
 5. Minimum length of color field and size of letters shall be in accordance with Uniform Plumbing Code requirements.
- B. Types:
1. Self-adhesive type: Seton Opti-Code.
 2. Snap-around type: Seton Setmark.
 3. Wrap-around type: Seton Ultra-mark; PVF over-laminated polyester construction seals in and protects graphics; suitable for outdoor or harsh environments.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 22 or 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. All scheduled equipment.
 - b. Space GAS monitor/transmitter device
- B. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.
1. Ceilings 10 feet and lower: Letters shall be 1/4" high, black.
 2. Ceilings higher than 10 feet: Letters shall be 3/8" high, black.
 3. Label all equipment above ceiling that requires servicing or access.
 4. Locate labels on the ceiling grid, adjacent to the ceiling tile that provides the best access to the valve or item that requires servicing.

3.3 PIPING IDENTIFICATION

- A. Piping Identification Types:
1. Piping or Insulation 5-7/8 inch OD or smaller: Snap-around marker or self-adhesive marker.
 2. Piping or Insulation 6 inch OD and Larger: Strap-around with nylon ties or self-adhesive marker.
 3. Provide wrap-around pipe markers for outdoor pipes. Install wrap-around pipe markers completely around pipe.
- B. Install manufactured pipe markers indicating service on each piping system.
1. Install pipe markers to manufacturer's instructions.
 2. Identify piping, concealed or exposed. Include service and flow direction.
 3. Install in clear view and align with axis of piping.
 4. Locate identification at maximum 20 feet centers on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
 5. At access doors, manholes, and similar access points that permit view of concealed piping.
 6. At least one per room.
- C. Unions covered by insulation: Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

3.4 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems
 - 2. Balancing Hydronic Piping Systems
 - 3. Testing, Adjusting, and Balancing Equipment
 - 4. Testing, adjusting, and balancing existing systems and equipment.
 - 5. Control system verification.

1.3 INFORMATIONAL SUBMITTALS

- A. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- B. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.4 QUALITY ASSURANCE

- A. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine terminal units and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.

- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Duct systems are complete with terminals installed.
 - b. Volume, smoke, and fire dampers are open and functional.
 - c. Clean filters are installed.
 - d. Fans are operating, free of vibration, and rotating in correct direction.
 - e. Variable-frequency controllers' startup is complete and safeties are verified.
 - f. Automatic temperature-control systems are operational.
 - g. Ceilings are installed.
 - h. Windows and doors are installed.
 - i. Suitable access to balancing devices and equipment is provided.
 - 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111 or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to the mechanical insulation specification.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, VFD's, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in the ductwork specification.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.

6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Check liquid level in expansion tank.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.

- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.

- D. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or temperature method.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

- E. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.

- F. Verify that memory stops have been set.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

- B. Adjust the variable-flow hydronic system as follows:
 - 1. Verify that the differential-pressure sensor is located as indicated.
 - 2. Determine whether there is diversity in the system.

- C. For systems with no diversity:
 - 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

- b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 4. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 5. Prior to verifying final system conditions, determine the system differential-pressure set point.
 6. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 7. Mark final settings and verify that all memory stops have been set.
 8. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.

9. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
6. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.

- b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
7. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
8. Prior to verifying final system conditions, determine system differential-pressure set point.
9. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
10. Mark final settings and verify that memory stops have been set.
11. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
12. Verify that memory stops have been set.

3.9 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.10 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
 1. Measure and record entering- and leaving-water temperatures.
 2. Measure and record water flow.
 3. Record relief valve pressure setting.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Airflow.

- B. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Airflow.

3.12 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 - 1. Verify temperature control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.13 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the refrigerant charge.
 - 4. Check the condition of filters.
 - 5. Check the condition of coils.
 - 6. Check the operation of the drain pan and condensate-drain trap.
 - 7. Check bearings and other lubricated parts for proper lubrication.
 - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.
 - 5. Bearings and other parts are properly lubricated.
 - 6. Deficiencies noted in the preconstruction report are corrected.

- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 - 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 - 4. Balance each air outlet.

3.14 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.

- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.16 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water flow rates.

3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btu/h.
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.

- m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

- I. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

- J. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..

 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.

- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.

 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.

- M. Instrument Calibration Reports:
 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.

- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

- A. Owner or Commissioning authority will randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- B. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- C. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- D. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
- E. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 7 for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Common Work Results for Mechanical"
 - 3. Division 23 Section "Hangers and Supports for Piping and Equipment" for pipe insulation shields and protection saddles.
 - 4. Division 23 Section "Metal Ducts" for duct liner.

1.2 SUMMARY

- A. This Section includes insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 ACTION SUBMITTALS

- A. Product Data: Identify thermal conductivity, Greenguard Certification, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
- C. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- C. Store tapes, adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer.
- D. Follow manufacturer's recommended handling practices.
- E. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- F. Fiber Glass and Mold: Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with other trades for insulation application.
- B. Schedule insulation application after testing systems. Insulation application may begin on segments of systems that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Certainteed
 - 2. Knauf
 - 3. Owens-Corning
 - 4. John Mansville
 - 5. Armstrong
 - 6. Aeroflex USA
 - 7. Nomaco K-Flex
 - 8. Pabco.

2.2 PIPING INSULATION MATERIALS

A. General

1. Supply fiber glass products that have achieved GREENGUARD Children & Schools Certification.
2. Surface Burning Characteristics: Insulation and related materials shall have surface burning characteristics determined by test performed on identical products per ASTM E 84 mounted and installed as per ASTM E 2231. All testing shall be performed by a testing and inspecting agency acceptable to authorities having jurisdiction. Insulation, jacket materials, adhesives, mastics, tapes and cement material containers shall be labeled with appropriate markings of applicable testing and inspecting agency. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. Supply fiber glass products that are manufactured using a certified 25 % minimum recycled content.

B. Provide thermal hanger shields as specified in Section 23 05 29.

C. Glass Fiber:

1. Knauf 1000° Pipe Insulation with ECOSE Technology meeting ASTM C547 Type IV Grade A, ASTM C585, and ASTM C795; rigid, molded, noncombustible per ASTM E136; k value: ASTM C335, 0.23 at 75°F mean temperature. Maximum Service Temperature: 1000°F, or Johns Manville's Micro-Lok® HP meeting ASTM C547, Type I, maximum service temperature of 850°F meeting the other requirements. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C1136 Type I, secured with self-sealing longitudinal laps and butt strips.
2. PVC Fitting Covers: The Proto Fitting Cover System or Johns Manville Zeston® polyvinyl chloride (PVC) parts shall consist of one piece and two piece pre-molded high impact UV-resistant PVC fitting covers with fiberglass inserts and accessories, which include elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings. Fittings shall be made of Zeston® or LoSMOKE® grade PVC, 25/50 rated per ASTM E-84. Thermal Value of fiberglass insert: K value of 0.26 at 75°F; resistance to fungi and bacteria. (ASTM G 21, ASTM G 22): does not promote growth of fungi or bacteria.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Materials shall have a maximum thermal conductivity of 0.27 Btu-in/h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
4. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure-A, latest revision.
5. Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.
6. Provide Armaflex WB finish for outdoor exposed piping.

- E. Calcium Silicate Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I. IIG Thermo-12 Gold, or approved equal.

2.3 DUCTWORK INSULATION MATERIALS

- A. Flexible Fiber Glass Blanket: Johns Manville's Microlite® XG Duct Wrap or Knauf Friendly Feel® Duct Wrap with ECOSE Technology meeting ASTM C553 Types I, II and III, and ASTM C1290; GREENGUARD certified; flexible, limited combustible; k value: ASTM C177, 0.29 at 75°F mean temperature. Maximum Service Temperature: faced: 250°F; unfaced: 350°F. Vapor Retarder Jacket: FSK conforming to ASTM C1136 Type II. Installation: Maximum allowable compression is 25%. Securement: Secured in place using outward cinching staples in combination with appropriate pressure-sensitive aluminum foil or PSK tape, or in combination with glass fabric and vapor retarder mastic. Density: concealed areas: Minimum 0.75 PCF; exposed areas: Minimum 1.0 PCF.
- B. Fire Protection Wrap: Thermal Ceramics FireMaster FastWrap XL or Pyroscat Duct Wrap XL shall be installed by qualified installer directly to the duct to provide a zero-clearance and 2-hour fire resistance-rated grease duct enclosure as required by IBC and as detailed in UL Listing HNKT.G-18 and tested per ASTM E 2336. Product shall be UL classified and labelled for the application. Provide for adequate clean out of commercial kitchen grease duct: Thermal Ceramics FastDoor XL; Access Doors to be installed by qualified installer as per UL Listing HNKT.G-18.

2.4 FIELD-APPLIED JACKETS FOR PIPING

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. PVC: Johns Manville's Zeston® PVC fittings, jacketing, and accessories or Proto Corporation 25/50 or Indoor/Outdoor, UV-resistant fittings, jacketing and accessories, white. Fitting cover system consists of pre-molded, high-impact PVC materials with fiber glass inserts. Fiber glass insert has a thermal conductivity (k value) of 0.26 at 75° F mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.
- C. Aluminum Jacket: Factory cut and rolled to required size. Comply with ASTM B 209, 3003 alloy, and H-14 temper. Finish and Thickness: Corrugated finish, 0.010 inch thick. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and Kraft paper. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

2.5 EXTERIOR DUCTWORK

- A. Rigid roof insulation board, 2-1/2" thickness; with high-performance jacketing: VentureClad-1577, or approved equal; high performance jacketing product shall perform well over a wide temperature range; -30°F to +300°F service temperature.
 - 1. Zero permeability, absolute vapor barrier
 - 2. High puncture and tear resistance
 - 3. Contain tested and approved mold inhibiting agents

4. A 5-ply self adhesive material shall install easily with no off-site fabrication required
5. The cold weather acrylic adhesive shall apply easily at temperatures as cold as -10°F.
6. Flame spread/smoke developed: 10/20 (UL 723)
7. 6-mil thickness (PSTC-133)
8. Exceeds standard building design requirements (UL 723 10/20 Flame Spread/Smoke Rating). Meets requirements of FSIS Directive 5000.1, 9 CFR, Part 416 for USDA and FDA facilities and Department of Health and Human Services Construction Guide for Food Facilities
9. Provide in natural aluminum stucco embossed finish.

2.6 ACCESSORY MATERIALS

- A. Accessory materials installed as part of insulation work under his section shall include (but not be limited to):
 1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
 2. Adhesive: As recommended by insulation material manufacturer. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated
 3. Support Materials - Hanger straps, hanger rods, saddles, support rings
- B. All accessory materials shall be installed in accordance with manufacturer's instructions.
- C. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION & PREPARATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application. Verify that systems to be insulated have been tested and are free of defects. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- D. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.2 GENERAL APPLICATION REQUIREMENTS

- A. Provide insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout, including the length of ducts and fittings, valves, and specialties.
- B. Provide insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each system as specified in insulation system schedules.
- C. Provide accessories compatible with insulation materials and suitable for the service. Provide accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Provide insulation with longitudinal seams at top and bottom of horizontal pipe runs and equipment.
- E. Provide multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Provide insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Provide insulation over fittings, valves, and specialties, with continuous thermal and least number of joints practical.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and specialties around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Provide insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 INSTALLATION OF PIPING INSULATION

- A. Metal shields shall be installed between hangers or supports and the piping insulation. Provide in accordance with Section 23 05 29.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- C. Insulate instrument connections for specialties (examples: thermometers, sensors, etc.) on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at fittings and equipment that require servicing and locations with service requirements.
- E. Glass Fiber Piping Insulation
1. Locate seams in the least visible location.
 2. Insulation installed on piping operating below ambient temperatures must have a continuous vapor retarder. All joints, seams and fittings must be sealed. On systems operating above ambient, the butt joints should not be sealed.
- F. Flexible Elastomeric Insulation
1. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 2. Insulation Installation on Pipe Flanges: Install pipe insulation to outer diameter of pipe flange. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 3. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 4. Insulation Installation on Valves and Pipe Specialties: Install preformed valve covers manufactured of same material as pipe insulation when available. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. Install insulation to flanges as specified for flange insulation application. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 5. After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Prior to applying the finish, the insulation shall be wiped clean with denatured alcohol. The finish shall not be tinted. To insure good adhesion, the temperature should be above 50 °F during application and drying. Outdoor exposed piping shall have the seams located on the lower half of the pipe.

6. Outdoor exposed piping shall be painted with two coats of Armaflex WB Finish. Prior to applying the Finish, the insulation shall be wiped clean with denatured alcohol. The Finish shall not be tinted. Outdoor exposed piping shall have the seams located on the lower half of the pipe.

3.4 INSTALLATION OF DUCTWORK INSULATION

A. Flexible Fiberglass Blanket Insulation Installation:

1. Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
3. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
4. Firmly butt all joints.
5. Where vapor retarder performance is required, all penetrations and damage to the facing shall be repaired using pressure-sensitive tape matching the facing, or mastic prior to system startup. Pressure-sensitive tapes shall be a minimum 3 inches wide and shall be applied with moving pressure using a squeegee or other appropriate sealing tool. Closure shall have a 25/50 Flame Spread/Smoke Developed Rating per UL 723. The longitudinal seam of the vapor retarder must be overlapped a minimum of 2 inches.
6. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Insulation shall be additionally secured to the bottom of rectangular ductwork over 24 inches wide using mechanical fasteners on 18-inch centers. Care should be exercised to avoid over-compression of the insulation during installation.
 - d. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - e. Do not over-compress insulation during installation. Install Duct Wrap using manufacturer's stretch-out tables to obtain specified R-value using a maximum compression of 25%.
 - f. Impale insulation over pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
8. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

9. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
1. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 2. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
- C. Fire-rated insulation system installation: Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating. Insulate duct access panels and doors to achieve same fire rating as duct.
1. Install 2 layers duct wrap.
 2. The inside and outside layers of the insulation blankets are cut to a length that will fit around the duct and meet with a tight butt joint. Adjacent blankets on the inside and outside layers are tightly butted against each other. Joints between blankets on the outside layer shall be offset from joints on the inside layer by a minimum 6 inches. Cut edges of the blanket shall be taped with aluminum foil tape. During installation the blankets are temporarily held in place with filament tape until the wrap is mechanically attached with steel bands or steel insulation pins.
 3. Install access doors per manufacturers' instructions, and applicable building code reports and laboratory design listings.

3.5 INSTALLATION OF EQUIPMENT/ TANK INSULATION

A. Fiber Glass

1. Apply insulation to the equipment surface with joints firmly butted and as close as possible to the equipment surface. Insulation shall be secured as required with mechanical fasteners or banding material. Fasteners shall be located a maximum of 3" from each edge and spaced no greater than 12" on center.
2. For below ambient systems, vapor retarder jacketing shall overlap a minimum of 2" at all seams and be sealed with appropriate pressure-sensitive tape or mastic. All penetrations and facing damage shall be covered with a minimum 2" overlap of tape or mastic.

B. Flexible Elastomeric:

1. Install insulation over entire surface of tanks and vessels.
2. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

3. Seal longitudinal seams and end joints.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
 - B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
 - C. Do not field paint aluminum or stainless-steel jackets.
 - D. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 PIPING INSULATION APPLICATION SCHEDULE

- A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. For piping systems not indicated, insulate to with a similar thickness and type as those specified.
- B. All cold surfaces that may "sweat" must be insulated. Vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. For above-ambient services, do not install insulation to the following: testing agency labels and stamps, nameplates, and cleanouts.

- D. Insulation thicknesses and installations shall meet or exceed the requirements of ASHRAE Standard 90.1-2007, IECC 2009, or thicknesses indicated, whichever is of superior insulating performance.
- E. If piping type is omitted from list below, provide insulation as per similar duty.
- F. Provide PVC jackets in the following locations:
 - 1. Exposed piping in finished spaces.
- G. Domestic hot water: 1/2" thickness, runouts and non-recirculated portions, except as noted below.
- H. Domestic hot water: 1-1/4" and less: Glass Fiber, 1" thickness; 1-1/2" and larger: Glass Fiber, 1.5" thickness: Recirculating piping including the supply and return.
- I. Domestic cold water: Glass Fiber, 1/2" thickness.
- J. Horizontal Rainwater conductors: Glass Fiber, 1" thickness. Provide for all horizontal piping and any vertical piping within 10 feet of the roof drain.
- K. Roof Drain Bodies: Flexible Elastomeric, 1/2" thickness.
- L. AC pan drain or other cold drain piping; (35° to 60°F): Flexible Elastomeric, 1/2" thickness; Note: Insulation not required for PVC piping at rooftop units.
- M. Ductless split: 1/2" Armaflex for liquid and gas piping. Coordinate with Section 23 83 10, insulated line kits may be furnished.
- N. Heating supply and return:
 - 1. Pipe size 1-1/4" and less: Glass Fiber or flexible Elastomeric; 1-1/2" thickness.
 - 2. PEX runout piping: 1" pre-insulated or field-insulated, mechanical contractor option. Coordinate with Section 23 21 13.
 - 3. PEX runout piping at ceiling of garage: 1-1/2" pre-insulated or field insulated, mechanical contractor option. Coordinate with Section 23 21 13.
 - 4. Pipe size 1-1/2" and larger: Glass Fiber; 2" thickness.
 - 5. Insulation is not required for exposed piping through floor for fintube radiators. Butt insulation to bottom of floor.
 - 6. Insulation is not required strainers, control valves, unions, and balancing valves associated with piping 1" or less diameter. Insulate piping to within approximately 1-inch of un-insulated items.
- O. Diesel Fire Pump engine exhaust: Cover exhaust completely from engine through roof or wall construction, including muffler: Calcium Silicate – two (2) layers of 1" thick insulation.

3.9 EQUIPMENT INSULATION

- A. For equipment not indicated, insulate to with a similar thickness and type as those specified.
- B. Install insulation over entire surface of tanks and vessels. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive. Seal longitudinal seams and end joints.

- C. For Equipment insulation exposed in mechanical rooms or subject to mechanical abuse, finish with minimum 0.020 inch thick PVC jacketing or metal or laminated self-adhesive water and weather seals. All other insulation shall be finished as appropriate for the location and service or as specified on the drawings.
- D. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
- E. Omit insulation from the following, except for cold surfaces, which shall be provided with removable covers:
 - 1. Hot water expansion tanks
 - 2. Hot water pumps
 - 3. Vibration-control devices.
 - 4. Testing agency labels and stamps.
 - 5. Nameplates and data plates.
 - 6. Manholes, hand holes, or cleanouts.
- F. Removable Covers for Maintenance Access: Construct insulation on equipment which must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Use $\frac{3}{4}$ " flexible elastomeric insulation.
- G. Air separators: same as water piping.

3.10 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section. For duct systems not indicated, insulate to with a similar thickness and type as those specified.
- B. Insulation thicknesses and installations shall meet or exceed the requirements of ASHRAE Standard 90.1-2007, or thicknesses indicated, whichever is of superior insulating performance.
- C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Metal ducts with duct liner.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums, casings, and access doors.
 - 4. Flexible connectors.

3.11 DUCT AND PLENUM APPLICATION SCHEDULE

- A. Supply Ducts: Flexible Fiber Glass Blanket;
 - 1. Concealed or Unconditioned Space: R-6, 1.5" thickness.
 - 2. Return Air Plenums: not applicable.
 - 3. Exposed to Conditioned Space: None
- B. Exterior Supply & Return Ducts: 2-1/2" Rigid Roof Insulation Board with high performance jacket; R10 minimum.

- C. Return ducts within conditioned space: None required.
- D. Outside air intake, combustion air, relief, or exhaust ducts and plenums within 30 feet of exterior: Flexible Fiber Glass Blanket; R-8, 2" thickness.
- E. Range Hood Exhaust: Fire protection wrap, 2 layers.

END OF SECTION 23 07 00

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all labor, materials, equipment, and service necessary for a complete and operating building automation system.
- B. The Controls Contractor's work shall consist of the provision of all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project-specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required by the Contract that are required for the functional turn-key operation of the complete and fully functional Controls Systems. Documents are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner.
- C. Related Sections include the following:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 - 2. Division 13 Section "Fire Alarm"
 - 3. Division 23 Section "Common Work Results for Mechanical"
 - 4. Division 23 Sections with controller interfaces.
 - 5. Division 23 Section "Testing, Adjusting, and Balancing"
 - 6. Division 26

1.2 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 3. Wiring Diagrams: Power, signal, and control wiring.
 4. Details of control panel faces, including controls, instruments, and labeling.
 5. Written description of sequence of operation.
 6. Schedule of dampers including size, leakage, and flow characteristics.
 7. Schedule of valves including flow characteristics.
 8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. List of I/O Points: Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), point connection terminal number. Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria.

1.3 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Qualification Data: For Installer and manufacturer.
- C. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.
- B. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.

1.5 QUALITY ASSURANCE

- A. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the owner's representative in writing. Spare parts shall be available for at least five years after completion of this contract.
- B. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer. Use only employees who are qualified, skilled, experienced, manufacturer trained and familiar with the specific equipment, software and configurations to be provided for this Project.
- C. Provide a complete, neat and workmanlike installation.
- D. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
- G. Comply with ASHRAE 135 for DDC system control components.

- H. The contractor shall protect all work and material from damage by his/her work or employees. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

1.6 CONTRACTOR QUALIFICATIONS

- A. Qualified Bidders: System shall be as manufactured, installed and serviced by:
 - 1. Schneider Electric I/A, (Maine Controls)
 - 2. Johnson Controls, Inc.
 - 3. Honeywell
 - 4. Siemens
 - 5. Approved bidders. Bids from other vendors, franchised dealers, manufacturer's representatives, or from contractors who are authorized to represent the above named manufacturers must be pre-approved.
- B. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- C. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, and controllers. All other products specified herein (e.g., sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.
- D. Longevity: The Facilities Management System contractor shall have a minimum of ten years experience installing, and servicing computerized Building Automation Systems (BAS). All subcontractors utilized by the BAS contractor shall have a minimum of five-year experience within their appropriate trades.
- E. Past Projects: The BAS contractor shall have completed a minimum of ten projects within the last five years that are at least equal in dollar value and scope to this project. A list of similar projects, dollar volume, scope, contact name and contact number shall be provided by the BAS contractor if asked for by the owner.
- F. Personnel, Coverage and Response Capabilities: The BAS contractor shall have a minimum of ten full time electronic service personnel within a 120 mile radius of the project location. One of the five full time electronic service personnel must work within a 60-mile radius of the project location.
- G. The BAS contractor shall have an established 24-hour emergency service organization. A dedicated telephone number shall be provided to the owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BAS contractor.
- H. Parts Stocking: The BAS contractor shall have an independently verifiable inventory of electronic service parts. This electronic service parts inventory must have a worth of at least \$100,000 per year over the last five years.

1.7 COORDINATION

- A. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition.
- B. Coordinate details of telephone line, internet service provider, and associated requirements.
- C. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- D. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.
- E. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the controls system specified in this section. These controls shall be integrated into the system and coordinated by the contractor.
- F. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.
- G. Sheet Metal Subcontractor:
 - 1. Installation of duct-mounted control devices.
 - 2. Access doors where indicated and as required for proper servicing.
 - 3. Furnishing and installing of smoke dampers and actuators required for duct smoke isolation. The BAS contractor shall interlock these dampers to the air systems as described in Sequences of Operation.
- H. HVAC Contractor:
 - 1. Installation of immersion wells and pressure tappings, along with associated shut-off cocks.
 - 2. Installation of flow switches.
 - 3. Installation of automatic control valves.
- I. Coordinate with controls specified in other sections of divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the BAS contractor as follows:
 - 1. All communication media and equipment shall be provided as specified hereinafter.
 - 2. Each supplier of a control product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 - 3. The BAS contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

4. The BAS contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.9 WARRANTY

- A. Refer to Division 1 Requirements.
- B. At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the engineer, the engineer shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty. All work shall have a single warranty date, even when the owner has received beneficial use due to an early system start-up.
- C. All components, system software, and parts supplied by the BAS contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date. The BAS contractor at no charge shall furnish Labor to repair, reprogram, or replace components during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 hours during normal business hours.
- D. Provide remote service diagnostic monitoring from the nearest service location. At the request of the owner, a service diagnostic call will be made to troubleshoot and resolve (if possible) any reported system complaints.
- E. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above-mentioned items also can be provided during the warranty period for an additional charge to the owner by purchasing an in-warranty service agreement from the contractor. Written authorization by the owner must, however, be granted prior to the installation of any of the above-mentioned items.

PART 2 - PRODUCTS

2.1 BUILDING AUTOMATION SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- C. Install new wiring and network devices as required to provide a complete and workable control network.
- D. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
 - 1. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 sec.
 - 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 - 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 - 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 - 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.
 - 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
 - 7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
 - 8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
 - 9. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Fluid Temperature: Plus or minus 0.5 deg F.
 - b. Fluid Flow: Plus or minus 5 percent of full scale.
 - c. Fluid Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.

- i. Relative Humidity: Plus or minus 3 percent.
- j. Carbon Monoxide: Plus or minus 5 percent of reading.
- k. Carbon Dioxide: Plus or minus 50 ppm.
- l. Electrical: Plus or minus 5 percent of reading.

2.2 DDC EQUIPMENT

A. Operator Workstation: One PC-based microcomputers with minimum configuration as follows:

1. Motherboard: With 8 integrated USB 2.0 ports, integrated PCIE 10/100/1000 network adapter
2. Processor: Intel® Core™ i7
3. Hard-Disk Drive: 500 GB.
4. Random-Access Memory: 8 GB
5. 320W 90% Efficient Power Supply, Energy Star 5.0 compliant
6. Graphics: card as recommended by BAS supplier for optimum performance.
7. Monitor: 17.3 inch High Definition LED Display (1600 X 900) with anti-glare
8. Keyboard: QWERTY, 105 keys in ergonomic shape.
9. 8X DVD+/-RW with double-layer DVD+/-R write capability
10. Mouse: Three button, optical.
11. APC BR1000G Back-UPS Pro 1000 VA 120V Power-Saving UPS System
12. Operating System: Windows 7 with high-speed Internet access.
13. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
14. Application Software:
 - a. I/O capability from operator station.
 - b. System security for each operator via software password and access levels.
 - c. Automatic system diagnostics; monitor system and report failures.
 - d. Database creation and support.
 - e. Automatic and manual database save and restore.
 - f. Dynamic color graphic displays with up to 10 screen displays at once.
 - g. Custom graphics generation and graphics library of HVAC equipment and symbols.
 - h. Alarm processing, messages, and reactions.
 - i. Trend logs retrievable in spreadsheets and database programs.
 - j. Alarm and event processing.
 - k. Object and property status and control.
 - l. Automatic restart of field equipment on restoration of power.
 - m. Data collection, reports, and logs. Include standard reports for the following:
 - 1) Current values of all objects.
 - 2) Current alarm summary.
 - 3) Disabled objects.
 - 4) Alarm lockout objects.
 - 5) Logs.
 - n. Custom report development.
 - o. Utility and weather reports.
 - p. Workstation application editors for controllers and schedules.
 - q. Maintenance management.

15. Custom Application Software:
 - a. English language oriented.
 - b. Full-screen character editor/programming environment.
 - c. Allow development of independently executing program modules with debugging/simulation capability.
 - d. Support conditional statements.
 - e. Support floating-point arithmetic with mathematic functions.
 - f. Contains predefined time variables.

- B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 3. Standard Application Programs:
 - a. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - b. Remote communications.
 - c. Maintenance management.
 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

- C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform

scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

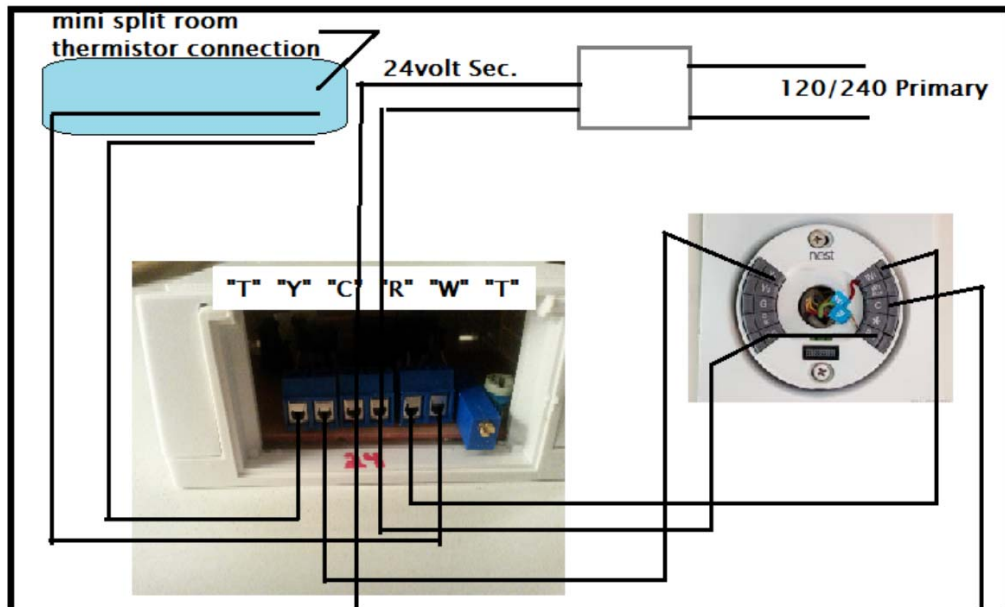
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.4 SENSING DEVICES

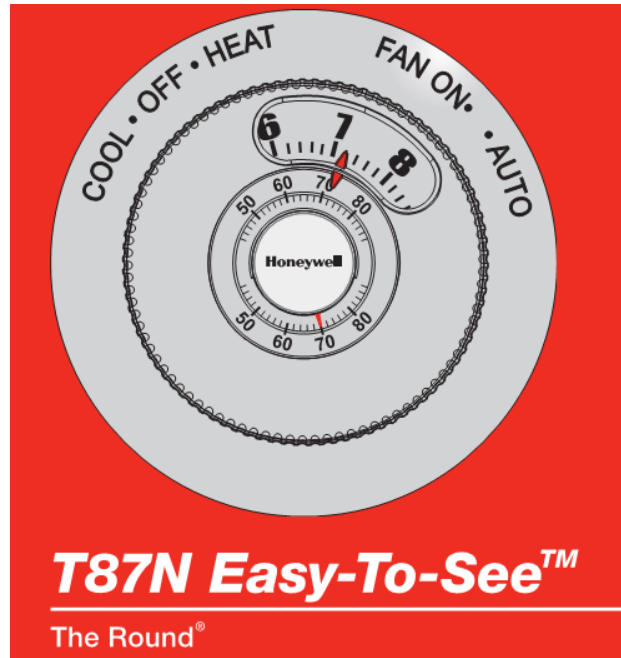
- A. Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary.
- B. Thermistors: Precision thermistors may be used in applications below 200 degrees F. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degree F cumulative. A/D conversion resolution error shall be kept to 0.1 degree F. Total error for a thermistor circuit shall not exceed 0.5 degree F.
- C. Resistance Temperature Detectors (RTDs): Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degree F cumulative. Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degree F.
- D. Temperature Sensor Details
 1. Room Type: Provide the sensing element components within a decorative protective cover suitable for surrounding decor.
 - a. Provide room temperature sensors with:
 - 1) Setpoint adjustment lever or knob.
 - 2) Digital temperature display.
 2. Duct Probe Type: Ensure the probe is long enough to properly sense the air stream temperature.
 3. Duct Averaging Type: Continuous averaging sensors shall be one foot in length for each 4 square feet of duct cross-sectional area, and a minimum length of 6 ft.
 4. Pipe Immersion Type: Provide minimum three-inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel when used in steel piping, and brass when used in copper piping. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior.
 5. Outside Air Type: Provide the sensing element on the building's north side with a protective weather shade that positions the sensor approximately 3 inches off the wall surface, does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain.

E. Ductless Splits:

1. Provide a ductless split interface adapter as manufactured by J.P. Manufacturing, Mitsubishi # PAC-US44CN-1, or approved equal. The "Universal Thermostat Adapter" shall be compatible with all Mini Split makes and models. The adapter shall work with all systems utilizing thermistor type sensors for temperature measurement. It shall also be compatible with all standard 24vac wall thermostats giving the user an infinite number of system/thermostat combinations. The adapter shall be field adjustable to enable the calibration of the adapter to match the mini split system if calibration is required. The adapter draws a maximum of 35mA and shall be powered by the control transformer powering the new thermostat. The "Universal Adapter" shall be designed to be surface mounted in any position, flush mounted within a concealed wall space or even mounted inside the indoor section equipment. The "Universal Adapter" requires no ventilation due to its very low power consumption of less than 1/2 Watt. The control transformer required to power the thermostat and adapter shall be provided.



2. Apartments: Provide a Honeywell T87N thermostat.



3. Other ductless splits and multi-splits: Provide a room type temperature sensor.
 - F. Transmitters: Provide transmitters with 4 to 20 mA or 0 to 10 VDC linear output scaled to the sensed input. Transmitters shall be matched to the respective sensor, factory calibrated, and sealed. Size transmitters for an output near 50 percent of its full-scale range at normal operating conditions. The total transmitter error shall not exceed 0.1 percent at any point across the measured span. Supply voltage shall be 12 to 24 volts AC or DC. Transmitters shall have non-interactive offset and span adjustments. For temperature sensing, transmitter drift shall not exceed 0.03 degrees F a year.
 - G. Relative Humidity Transmitters: Provide transmitters with an accuracy equal to plus or minus 3 percent from 0 to 90% scale, and less than one percent drift per year. Sensing elements shall be the polymer type. Vaisala Model HMD50U or equal.
 - H. Current Transducers: Provide current transducers to monitor motor amperage, unless current switches are shown on design drawings or point tables.
 - I. Input Switches
 1. Timed Local Overrides: Provide buttons or switches to override the DDC occupancy schedule programming for each major building zone during unoccupied periods, and to return HVAC equipment to the occupied mode. This requirement is waived for zones clearly intended for 24 hour continuous operation.
 2. Freeze Protection Thermostats: Provide special purpose thermostats with flexible capillary elements 20 feet minimum length for coil face areas up to 40 square feet. Provide longer elements for larger coils at 1-foot of element for every 4 square feet of coil face area, or provide additional thermostats. Provide switch contacts rated for the respective motor starter's control circuit voltage. Include auxiliary contacts for the switch's status condition. A freezing condition at any 18-inch increment along the sensing element's length shall activate the switch. The thermostat shall be equipped with a

manual push-button reset switch so that when tripped, the thermostat requires manual resetting before the HVAC equipment can restart.

- J. Hydronic Remote Differential Pressure Transmitters: Bell & Gossett ST Series; Setra, or approved equal; with 3-valve manifold for ease of maintenance. A differential pressure transmitter shall for each hydronic loop being monitored; for measuring differential pressure and transmitting an isolated linear 4-20 mA dc output. Each transmitter shall be connected by the contractor to the supply and return lines at the most remote point of each loop being monitored. The unit shall be accurate to $\pm 0.07\%$ of full span, and shall withstand over ranges up to a static pressure of 2300 psi with negligible change in output. It shall have stainless steel wetted parts with 1/4" NPT process connection. Unit shall be protected against radio frequency interference and shall have a water tight (NEMA Type 6/6P) electrical enclosure with 1/2" NPT conduit connection.
- K. Gas Detection
1. Natural Gas (Ch4) Transmitter; Kele Model GMT gas monitor/transmitter or equal. Microprocessor-based system for continuous effective monitoring of *combustible* gases. Provide 4-20 mA output in proportion with DPDT alarm contacts; Gas concentration display: 10-step progressive LED; Visual Indicators shall be Green light "normal operation"; Provide audible alarm: 65 dbA at 3 ft; Catalytic combustion S1-type sensor; UL listed; 2 year warranty
 - a. Detection range: 0-100% L.E.L. (Lower Explosive Limit)
 - b. Accuracy 3%
 - c. Alarm set point: 1.25% Methane by volume (25% L.E.L).
 2. Carbon Monoxide (CO) Monitor / Transmitter: Kele Model GMT gas monitor/transmitter or approved equal. Microprocessor-based system for continuous effective monitoring of *toxic* gases. Provide 4-20 mA output in proportion with DPDT alarm contacts; Gas concentration display: 10-step progressive LED; Visual Indicators shall be Green light "normal operation"; Provide audible alarm: 65 dbA at 3 ft.; Electromechanical S1-type sensor; UL listed; 2 year warranty
 - a. Detection range: 0-500 ppm
 - b. Accuracy 3%
 - c. Alarm set point 35 ppm
 3. Garage CO Detector:
 - a. Macurco Model DVP-120 exhaust fan controller, or approved equal by Intec; in conjunction with Macurco gas transducers, provides automatic controls to help maintain an acceptable environment in parking garages or other facilities. The DVP-120 system is designed to meet specifications for safety in enclosed parking garages, including the Uniform Building Code and OSHA 50ppm CO requirements. The DVP-120 can control up to twelve gas sensors in any combination.
 - 1) External keypad for user selection of the transducer/alarm display and setting the configuration

- 2) Externally visible LCD display showing the status of each transducer and relay
 - 3) Externally visible system, alarm and relay status indicators
 - 4) Compatible with all Macurco™ 6-Series gas sensors
 - 5) Twelve analog (current loop) input channels
 - 6) Three 10A, 240 VAC SPDT fan/alarm relays
 - 7) Drivers for external Horn and Strobe
 - 8) Fail safe operation can be implemented
 - 9) Lockable NEMA 1 type enclosure
 - 10) Modular input and output connectors
 - 11) ETL Listed to UL 508A, CAN/CSA-C22.2 No. 14-13, LADBS Approved
 - 12) Up to three ventilation control zones can be defined
 - 13) Each zone can be controlled based on transducer signals and/or time of day
 - 14) Each relay is configurable for delay before activation and minimum on time
- b. System wiring includes the main power connection for the DVP-120, 4-20mA current loop and 24VDC power connections between the remote sensors and the DVP-120, the fan control connections and alarm connections from the DVP-120 to the building ventilation and automation systems. All power and signal connections for the sensors are provided from the DVP-120 control panel, via unshielded four conductor cable. The DVP-120 control panel provides three relays which can be used for ventilation fan control or alarm signaling. The ventilation control function operates independently from the alarm function. It provides the ability to configure the DVP-120 for control of one to three zones. Each zone can respond to gas levels at one or more of the sensors, with configurable rising and falling concentrations for each gas type.
- c. Provide a MRS-485 adapter to provide a 4-20mA signal to the BAS.
- d. Provide a minimum of four of each sensor in order to maintain proper coverage per manufacturer's recommendations. Refer to Sheet MH1.0.C for proposed layout.
- 1) Carbon Monoxide Detection and Control: The Macurco CM-6 is a low voltage, dual relay Carbon Monoxide (CO) detector, controller and transducer. The CM-6 has selectable 4-20 mA output, buzzer and digital display options. It is an electronic detection system used to measure the concentration of CO and provide feedback and automatic exhaust fan or valve control to help reduce CO concentrations in parking garages, maintenance facilities or other commercial applications. The CM-6 is a low level meter capable of displaying from 0-200 ppm of Carbon monoxide. Selectable options include: Fan relay actuation: selectable at 15, 25, 35 (default), 50 or 100 ppm CO; Output: Fan relay, Alarm relay and 4-20mA current loop; Controls: Digital display (0-200ppm), buzzer, fan delay, fan minimum runtime
 - 2) Nitrogen Dioxide Detection and Control: The Macurco TX-6-ND is a low voltage, dual relay Nitrogen Dioxide (NO₂) detector, controller and transducer. NO₂ is a toxic chemical of concern in diesel exhaust. The TX-6-ND has selectable 4-20 mA output, buzzer and digital display options. It is an electronic detection system used to measure the concentration of NO₂ and provide feedback and automatic exhaust fan control to help reduce NO₂ concentrations in parking garages. The TX-6-ND is a low level meter capable of displaying from 0-20 ppm of Nitrogen Dioxide. Selectable options include: • Fan relay actuation: selectable from 0.5 to 5.0 ppm NO₂;

Output: Fan relay, Alarm relay and 4-20mA current loop; Controls: Digital display (0-20 ppm), buzzer, fan delay, fan minimum runtime.

- e. Provide a calibration tool kit.
4. Carbon-Dioxide (CO₂) Sensor:
 - a. Manufacturers: Vaisala GMW21 and GMD20 Series, Honeywell Model C7232, MSA Airox Model 711271, GE-Telaire.
 - b. Analog and a relay output, use non-dispersive infrared (NDIR) technology, and feature a unique corrosion-free sensing chamber for accurate, stable CO₂ sensing.
 - c. Gold-plated sensor for long-term calibration stability
 - d. Automatic Background Calibration (ABC) algorithm based on long-term evaluation to reduce required maintenance. Manufacturer recommended calibration interval shall not be less than five years.
 - e. Configuration as indicated: Wall mount with LCD to provide sensor readings and status information or Duct mount

2.5 OUTPUT HARDWARE

- A. Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:
 1. Submittals shall include leakage, maximum airflow and maximum pressure ratings based on AMCA Publication 500.
 2. Dampers shall meet the leakage requirements of the International Energy Conservation Code by leaking less than 3 cfm/sq. ft. at 1" of static pressure and shall be AMCA licensed as Class 1A.
 3. Dampers shall be Ruskin model CD60, or approved equal.
 4. Control dampers shall be the parallel or opposed blade type as follows: M dampers shall be the opposed blade type. Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals.
 5. Frame: 5 inches x minimum 16 gage roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage U-channel. Damper blades shall not exceed 8 inches in width or 48 inches in length. Blades shall be suitable for medium velocity performance 2000 fpm. Blades shall be not less than 16-gauge.
 6. Bearings shall be corrosion resistant, permanently lubricated stainless steel sleeve type turning in an extruded hole in the damper frame.
 7. All blade edges, top, and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel.
 8. Individual damper sections shall not be larger than 48 in. x 60 in. Provide a minimum of one damper actuator per section.
 9. Modulating dampers shall provide a linear flow characteristic where possible.
 10. Dampers shall have exposed linkages. Dampers over 48" in applications where sectioning is not applicable shall be supplied with a jackshaft to provide sufficient force throughout the intended operating range.

B. Thermally Insulated Control Damper

1. Ruskin Model: CDTI-50BF.
2. Frame: 6 inches x 1 inch x minimum 0.125 inch 6063-T5 extruded aluminum channel. Two thermal isolation breaks filled with polyurethane and de-bridged. Mounting Flanges: Both sides of flange frame.
3. Blades:
 - a. Material: Minimum 0.075 inch 6063-T5 extruded aluminum.
 - b. Width: Maximum 6 inches.
 - c. Style: Airfoil-shaped.
 - d. Action: Parallel.
 - e. Orientation: Horizontal or Vertical as indicated on the architectural drawings.
 - f. . Foam Isolation: Injected with 2-part, high-density, CFC-free, polyurethane foam.
 - g. Thermal Isolation Gap: Each blade underneath tooled blade edge seal pocket.
4. Thermal Transfer:
 - a. Both sides of blade shall be isolated from each other eliminating thermal transfer.
 - b. Damper blade overlap and thermal break shall be oriented to eliminate thermal transfer from 1 side of blade skins to other.
 - c. No downstream blade skin shall be exposed to upstream temperatures or conditions.
5. Linkage: Concealed in equal flanged frame.
6. Axles: Minimum 1/2 inch diameter plated steel, hex-shaped, mechanically locked internally into blade.
7. Bearings: Pressure-molded low temperature Lexan bearings.
8. Seals: Blade: Low temperature extruded Ruskiprene II with flame and smoke rating of 25/50. Mechanically attached to blade edge. Jamb: Polycarbonate.
9. Control Shaft: Removable, 1/2 inch diameter shaft extends 6 inches beyond frame.
10. Temperature Rating: -70 to 200 degrees F.
11. Finish: Mill aluminum.
12. Assembly: Factory assemble low temperature control damper, actuator, options, and accessories, and furnish as a single factory-calibrated unit.
13. Dampers shall meet the leakage requirements of the International Energy Conservation Code by leaking less than 3 cfm/sq. ft. at 1" of static pressure and shall be AMCA licensed as Class 1A.

C. Electronic damper/valve actuation shall be provided.

1. Manufactured, brand labeled or distributed by BELIMO, or approved equal.
2. Size for torque required for damper seal at load conditions.
3. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
4. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
5. Overload protected electronically throughout rotation.
6. Fail-Safe Operation: Mechanical, spring-return mechanism.
7. Proportional Actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.

8. Proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
 9. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal.
 10. Temperature Rating: -22 to +122°F -30 to +50°C [-58 to +122°F -50 to +50°C]
 11. Housing: Minimum requirement NEMA type 2 mounted in any orientation. .
 12. Agency Listings: ISO 9001, cULus, CE or CSA
 13. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
- D. Control Valves: Control valves shall be two-way or three-way type for two-position or modulating service as shown.
1. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Two-way: 150% of total system (pump) head.
 - b. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - c. Two-position service: Line size.
 - d. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, which ever is greater.
 - e. Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.
 2. Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 3. Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
 4. Water valves shall fail normally open or closed, as specified.
- E. Distribution Manifold Assemblies, used for PEX runouts to fintube.
1. Uponor, Caleffi, Watts, or approved equal.
 2. Pre-assembled distribution manifold consisting of return distribution manifold and supply distribution manifold consisting of return distribution manifold and supply distribution manifold. Provided with brass body, EPDM seals and available in models ranging from 2 to 8 outlets. Loop quantity as needed.
 3. 1-1/4 inch NPT inlet ball valves at supply and return
 4. ¾" zone outlets.
 5. Balancing valves at return side
 6. Air vent/drain cock.
 7. Maximum working pressure: 150 psi.
 8. Suitable fluids: water or 50 percent maximum propylene glycol solution.
 9. Maximum working temperature: 210°F.
 10. Provide with universal PEX circuit connection pipe fittings.
 11. Provide with electric or thermo-electric actuators. Provided with manual open/close knob with automatic reset, visual pop-up position indicator when activated, self-extinguishing

polycarbonate protective shell, protection class IP 40 installed in vertical position. Fabricated with double insulation in accordance with CE standards.

12. Mounting brackets, ceiling or wall hung as applicable.

- F. Output Switches: Control Relays; Field installed and DDC panel relays shall be double pole, double throw, UL864 listed, with contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without tools or removing wiring. Encapsulated "PAM" type relays may be used for terminal control applications.

2.6 STATUS SENSORS

- A. Status Inputs for Electric Motors: Veris Hawkeye 708/908 Series, or approved equal; solid- and split-core adjustable current sensors designed to provide accurate, reliable and maintenance-free fan and pump status indication. Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- B. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- C. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- D. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.7 ELECTRICAL POWER AND DISTRIBUTION

- A. Transformers: Transformers shall conform to UL 506. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.
- B. Surge and Transient Protection
1. Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.
 2. Power Line Surge Protection: Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:
 - a. The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.
 - b. The device shall react within 5 nanoseconds and automatically reset.
 - c. The voltage protection threshold, line to neutral, shall be no more than 211 volts.
 - d. The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.

- e. The primary suppression system components shall be pure silicon avalanche diodes.
 - f. The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.
 - g. The device shall have an indication light to indicate the protection components are functioning.
 - h. All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.
 - i. The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.
 - j. The device shall comply with IEEE C62.41.1 and IEEE C62.41.2, Class "B" requirements and be tested according to IEEE C62.45.
 - k. The device shall be capable of operating between -20 degrees F and 122 degrees F.
3. Telephone and Communication Line Surge Protection: Provide surge and transient protection for DDC controllers and DDC network related devices connected to phone and network communication lines. The device shall provide continuous, non-interrupting protection, and shall automatically reset after safely eliminating transient surges. The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology. The device shall be installed at the distance recommended by its manufacturer.
 4. Controller Input/Output Protection: Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.
- C. Wiring: Provide complete electrical wiring for the DDC System, coordinate line of demarcation with Division 26. Unless indicated otherwise, provide all normally visible or otherwise exposed wiring in conduit. Where conduit is required, control circuit wiring shall not run in the same conduit as power wiring over 100 volts. Circuits operating at more than 100 volts shall be in accordance with Division 26. Run all circuits over 100 volts in conduit, metallic tubing, covered metal raceways, or armored cable. Use plenum-rated cable for circuits under 100 volts in enclosed spaces. Examples of these spaces include HVAC plenums, within walls, attics, or above suspended ceilings.
- D. Power Wiring: The following requirements are for field-installed wiring:
1. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.
 2. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.
- E. Analog Signal Wiring: Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed before proceeding with installation.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and the expense of—this contractor.

3.2 INSTALLATION

- A. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation. Connect and configure equipment and software to achieve sequence of operation specified.
- B. Install all components in accordance with the manufacturer's recommendations. Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.
- C. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- D. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.
- F. Temperature Sensors: Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.
- G. Room Temperature Sensors: Verify location of thermostats and other exposed control sensors with plans and room details before installation. Mount the sensors on interior walls to sense the

average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of the sensor 48 inches above the floor to meet ADA requirements.

H. Duct Temperature Sensors

1. Probe Type: Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. Seal the duct insulation penetration vapor tight.
2. Averaging Type (and coil freeze protection thermostats): Weave the capillary tube sensing element in a serpentine fashion perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports. Prevent contact between the capillary and the duct or air handler internals. For sensors inside air handlers, the sensors shall be fully accessible through the air handler's access doors without removing any of the air handler's internals.

I. Outside Air Temperature Sensors: Provide outside air temperature sensors in weatherproof enclosures on the north side of the building, away from exhaust hoods and other areas that may affect the reading. Provide a shield to shade the sensor from direct sunlight.

J. Gas Monitor/Transmitters: Verify location of transmitter with room layout and details before installation. Do not exceed the manufactures' recommended maximum surveillance radius. Provide proper quantity as required. Mounting height shall be at manufacturer recommended height for the gas being sensed.

K. Install automatic dampers according to Section 233113 "Ductwork."

L. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

M. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

N. Install hydronic instrument wells, valves, and other accessories according to Section 232116 "Hydronic Piping Specialties." Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermal conductivity material within the well to fully coat the inserted sensor.

O. Install duct volume-control dampers according to Section 233113 "Ductwork"

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- C. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6. Test each system for compliance with sequence of operation.
 - 7. Test software and hardware interlocks.
- B. DDC Verification:
 - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 2. Check instruments for proper location and accessibility.
 - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4. Check temperature instruments and material and length of sensing elements.
 - 5. Check control valves. Verify that they are in correct direction.

6. Check DDC system as follows:
 - a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - b. Verify that spare I/O capacity has been provided.
 - c. Verify that DDC controllers are protected from power supply surges.
- C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
- D. Garage Gas Detection.
 1. Commissioning and Start-up : A factory trained gas control system service technician should perform the following:
 - a. Thoroughly check that onsite assembled equipment, specified cables, control unit stations, remote sensors/transmitters & other field control modules are properly placed and installed.
 - b. Verify that electrical connections follow electrical and building codes. The wiring end must terminate correctly.
 - c. Apply calibration gases on the sensors in order to test the correct functions of the alarm setpoints and verify the operations sequence of the carbon monoxide detection and control system.
 - d. Issue a written report of the test results and corrective actions to be completed if required.
 - e. The report should include the verification of all devices, i.e. remote strobe, horn, sign, other alarm units and protective equipment, etc.
 - f. Malfunctioning products are repaired or replaced.
 2. Performance Demonstration and Training: The building owner's maintenance personnel shall be trained by a qualified gas system service technician. This individual will be responsible for changing setpoints & operations sequence, troubleshooting, performing scheduled maintenance, and calibrating the CO detection and control system using the appropriate tools and test gases.

3.5 ADJUSTING

- A. Calibrating and Adjusting:
 1. Calibrate instruments.
 2. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 3. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

4. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
 5. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 6. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 7. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 8. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 9. Provide diagnostic and test instruments for calibration and adjustment of system.
 10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.
- D. Garage Gas Detection: A qualified gas control system service technician should perform the following:
1. Thoroughly check that onsite assembled equipment, specified cables, control unit stations, remote sensors/transmitters & other field control modules are properly placed and installed.
 2. Verify that electrical connections follow electrical and building codes. The wiring end must terminate correctly.
 3. Apply calibration gases on the sensors in order to test the correct functions of the alarm setpoints and verify the operations sequence of the gas detection and control system.
 4. Issue a written report of the test results and corrective actions to be completed if required.
 5. The report should include the verification of all devices, i.e. remote strobe, horn, sign, other alarm units and protective equipment, etc.
 6. Malfunctioning products shall be repaired or replaced.
 7. The building owner's maintenance personnel should be trained by a qualified gas system service technician. This individual will be responsible for changing setpoints & operations sequence, troubleshooting, performing scheduled maintenance, and calibrating the detection and control system using the appropriate tools and test gases.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."
- B. Provide a qualified instructor (or instructors) with five years minimum field experience with the installation and programming of similar BACnet DDC systems. Orient training to the specific systems installed. Coordinate training times with the Owner. Training shall take place at the job site.
- C. This training shall last 16 hours and shall be conducted at the DDC system workstation, at a notebook computer connected to the DDC system in the field, and at other site locations as necessary. Upon completion of the Training, each trainee should fully understand the project's DDC system operation. The training session shall include the following:
- D. Provide basic control system fundamentals training.
 - 1. This project's list of control system components
 - 2. This project's list of points and objects
 - 3. This project's device and network communication architecture
 - 4. This project's sequences of control, and:
 - 5. Alarm capabilities
 - 6. Trending capabilities
 - 7. Troubleshooting communication errors
 - 8. Troubleshooting hardware errors
- E. Provide additional project-specific training:
 - 1. A walk-through tour of the mechanical system and the installed DDC components (controllers, valves, dampers, surge protection, switches, thermostats, sensors, etc.)
 - 2. A discussion of the components and functions at each DDC panel
 - 3. Logging-in and navigating at each operator interface type
 - 4. Using each operator interface to find, read, and write to specific controllers and objects
 - 5. Modifying and downloading control program changes
 - 6. Modifying setpoints
 - 7. Creating, editing, and viewing trends
 - 8. Creating, editing, and viewing alarms
 - 9. Creating, editing, and viewing operating schedules and schedule objects
 - 10. Backing-up and restoring programming and data bases
 - 11. Modifying graphic text, backgrounds, dynamic data displays, and links to other graphics
 - 12. Creating new graphics and adding new dynamic data displays and links
 - 13. Alarm and Event management
 - 14. Adding and removing network devices

3.7 TEST AND BALANCE SUPPORT

- A. The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel This support shall include:

1. On-site operation and manipulation of control systems during the testing and balancing.
2. Control setpoint adjustments for balancing all relevant mechanical systems.
3. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.8 CONTROLS SYSTEM OPERATORS MANUALS

- A. Provide three electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.
- B. Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Owner, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.
- C. Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:
 1. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications.
 2. A copy of the project's mechanical design drawings, including any official modifications and revisions.
 3. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."
 4. A copy of the project's approved Performance Verification Testing Plan and Report.
 5. A copy of the project's approved final TAB Report.
 6. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.
 7. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.
 8. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.
 9. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and notebook, and programming manuals for the workstation and notebook software.
 10. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.
 11. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Owner for a minimum of two years from contract acceptance. Include a table of all DDC system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

3.9 CLEANING

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be required to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

END OF SECTION 23 90 00

SECTION 23 09 01 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for Mechanical"
 - 2. Division 26

1.3 SUBMITTALS

- A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.
- C. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for VFDs and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 COORDINATION

A. Coordinate power wiring to VFD with Division 26.

B. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Honeywell SmartVFD
 2. Eaton H-Max Series
 3. ABB ACH550
 4. Cerus Industrial P Series
 5. Danfoss VLT HVAC Drive
 6. GE AF-600 FP
 7. Allen-Bradley PowerFlex 700
 8. Toshiba VF-FS1
 9. Yaskawa E7 Series
 10. Siemens Micromaster

2.2 VARIABLE FREQUENCY DRIVES

- A. The VFDs shall be rated for voltage as scheduled. The VFD shall provide microprocessor based control for three-phase induction motors. The controller's full load output current rating shall be based on Variable Torque application at 40° C ambient and 1-16 kHz switching frequency below 50 HP and 1-10 kHz 50 HP and above to reduce motor noise and avoid increased motor losses.
- B. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFD are not accepted. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not accepted. The VFD shall run at the above listed switching frequencies.
- C. The VFD shall have an efficiency at full load and speed that exceeds 95% for VFD below 15 HP and 97% for drives 15 HP and above. The efficiency shall exceed 90% at 50% speed and load.
- D. The VFD shall maintain a minimum line side displacement power factor of 0.96, regardless of speed and load. The VFD shall have a one (1) minute overload current rating of 110% for variable torque applications.
- E. The VFD shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
- F. The VFD shall have an integral EMI/RFI filter as standard.
- G. The VFD shall limit harmonic distortion reflected onto the utility system to voltage and current levels as defined by IEEE 519-1992 for general systems applications, by utilizing the standard 3% nominal impedance integral AC three-phase line reactor. DC link chokes are not accepted.

- H. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling (PCC) being the point where the utility feeds multiple customers.
- I. Total harmonic distortion shall be calculated under worst case conditions in accordance with the procedure outlined in IEEE 519-1992. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.
- J. The system containing the VFD shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992. If the system cannot meet the harmonic levels with the VFD provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply an eighteen pulse, multiple bridge rectifier, AC to DC conversion section with phase shifting transformer for all drives above 75 HP. This eighteen pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not accepted above 75 HP.
- K. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
- L. Standard operating conditions shall be:
 - 1. Incoming Power: Three-phase, VAC as scheduled (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
 - 2. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
 - 3. Speed regulation of +/- 0.5% of base speed.
 - 4. Load inertia dependant carryover (ride-through) during utility loss.
 - 5. Insensitive to input line rotation.
 - 6. Humidity: 0 to 95% (non-condensing and non-corrosive).
 - 7. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
 - 8. Ambient Temperature: -10 to 40 °C (VT).
 - 9. Storage Temperature: -40 to 70 °C.
- M. Control Functions
 - 1. Frequently accessed VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not accepted, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
 - 2. The keypad shall include a Hand-Off-Auto membrane selection and an Inverter/Bypass membrane selection. When in "Hand" the VFD will be started and the speed will be controlled from the up/down arrows. When in "Off", the VFD will be stopped. In "Auto",

- the VFD will start via an external contact closure or a communication network and the VFD speed will be controlled via an external speed reference.
3. The keypad shall have copy / paste capability.
 4. Upon initial power up of the VFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.
 5. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the VFD' RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this section through Section 18.
 6. The operator shall be able to scroll through the keypad menu to choose between the following:
 - a. Parameter Menu
 - b. Keypad Control
 - c. System Menu
 - d. Expander Boards
 - e. Monitoring Menu
 - f. Operate Menu
 7. The following setups and adjustments, at a minimum, are to be available:
 - a. Start command from keypad, remote or communications port
 - b. Speed command from keypad, remote or communications port
 - c. Motor direction selection
 - d. Maximum and minimum speed limits
 - e. Acceleration and deceleration times, two settable ranges
 - f. Critical (skip) frequency avoidance
 - g. Torque limit
 - h. Multiple attempt restart function
 - i. Multiple preset speeds adjustment
 - j. Catch a spinning motor start or normal start selection
 - k. Programmable analog output
- N. The VFD shall have the following system interfaces:
1. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following available as a minimum:
 - a. Remote manual/auto
 - b. Remote start/stop
 - c. Remote forward/reverse
 - d. Remote preset speeds
 - e. Remote external trip
 - f. Remote fault reset
 - g. Process control speed reference interface, 4-20mA DC
 - h. Potentiometer or process control speed reference interface, 0 -10VDC
 - i. RS-232 programming and operation interface port

2. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum:
 - a. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
 - 1) Fault
 - 2) Run
 - 3) Ready
 - 4) Reversing
 - 5) Jogging
 - 6) At speed
 - 7) In torque limit
 - 8) Motor rotation direction opposite of commanded
 - 9) Over-temperature
 - b. Programmable open collector output with available 24 Vdc power supply and selectable with the following available at minimum:
 - 1) Fault
 - 2) Run
 - 3) Ready
 - 4) Reversing
 - 5) Jogging
 - 6) At speed
 - 7) In torque limit
 - 8) Motor rotation direction opposite of commanded
 - 9) Overtemperature
 - c. Programmable analog output signal, selectable with the following available at minimum:
 - 1) Output frequency
 - 2) Frequency reference
 - 3) Motor speed
 - 4) Output current
 - 5) Motor torque
 - 6) Motor power
 - 7) Motor voltage
 - 8) DC link voltage
 - 9) PID controller reference value
 - 10) PID controller actual value 1
 - 11) PID controller actual value 2
 - 12) PID controller error value
 - 13) PID controller output
3. Capability of two additional expandable I/O interface cards. Upon installation, software shall automatically identify the interface card and activate the appropriate parameters. This should be done without adding any new software.

O. Monitoring and Displays

1. The VFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
 - a. Run
 - b. Forward
 - c. Reverse
 - d. Stop
 - e. Ready
 - f. Alarm
 - g. Fault
 - h. Input/Output (I/O) Terminal
 - i. Keypad
 - j. Bus/communication
 - k. Hand
 - l. Auto
 - m. Off

2. The VFD keypad shall be capable of displaying the following monitoring functions at a minimum:
 - a. Motor Speed (RPM and %)
 - b. Frequency reference
 - c. Output frequency
 - d. Motor current
 - e. Motor torque
 - f. Motor power
 - g. Motor voltage
 - h. DC-link voltage
 - i. Heat sink temperature
 - j. Motor run time (resettable)
 - k. Total operating days counter
 - l. Operating hours (resettable)
 - m. Total megawatt hours
 - n. Megawatt hours (resettable)
 - o. Voltage level of analog input
 - p. Current level of analog input
 - q. Digital inputs status
 - r. Digital and relay outputs status
 - s. Motor temperature rise
 - t. PID references

P. Protective Functions

1. The VFD shall include the following protective features at minimum:
 - a. Over-current
 - b. Over-voltage
 - c. System fault
 - d. Under-voltage

- e. Input line supervision
 - f. Output phase supervision
 - g. Under-temperature
 - h. Over-temperature
 - i. Motor stalled
 - j. Motor over temperature
 - k. Motor under-load
 - l. Logic voltage failure
 - m. Microprocessor failure
 - n. Brake chopper supervision
 - o. DC Injection braking
2. The VFD shall provide ground fault protection during power-up, starting, and running. VFD with no ground fault protection during running are not accepted.

Q. Diagnostic Features

1. Active Faults
2. The last 10 faults shall be recorded and stored in sequential order
3. Fault code and description of fault shall be displayed on the keypad.
4. Fault or alarm LED shall blink
5. Display drive data at time of fault
6. In the event several faults occur simultaneously, the sequence of active faults shall be viewable.
7. During a fault, the drive must be able to identify the following:
 - a. Drive Speed
 - b. Running hours
 - c. Running Days
 - d. Amps during fault
 - e. Motor Power
 - f. Motor Torque
 - g. DC bus Voltage
 - h. Drive Temperature
8. Fault History
 - a. The last 30 faults shall be recorded and stored in sequential order.
 - b. Display drive data at time of fault

R. Additional features included in the VFD:

1. The following indicating lights shall be provided on the keypad.
 - a. Drive Ready
 - b. Drive Run
 - c. Drive Fault
2. The current withstand rating of the drive shall be 100,000 AIC. The rating of the complete drive assembly shall be UL tested and listed at 65kAIC.
3. Communication card for interface with a BACnet control system.

4. The VFD shall have a cooling fan that is field replaceable using non-screw accessibility.
- S. Enclosure
1. The VFD shall be designed in a NEMA Type [1- general purpose] [12-drip tight] [3R-rain proof] enclosure. Packaging of the drive shall be designed and manufactured by the manufacturer of the drive for quality assurance.
 2. The VFD shall have complete front accessibility with easily removable assemblies.
 3. Cable entry shall be bottom entry.
- T. Disconnect Switch: allows a convenient means of disconnecting the drive from the line; operating mechanism can be padlocked in the OFF position; factory-mounted in the enclosure.
- U. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. Anchor each VFD assembly to steel-channel sills or unitstrut arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.
- B. Comply with mounting and anchoring requirements specified in Division 26.
- C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according with labeling that indicates the controlled device.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices according to Division 26. Bundle, train, and support wiring in enclosures.
- B. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with 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.

3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.7 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Engineer or authorized service representative to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD's on the job site. Sales representatives will not be accepted to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
 - 1. Inspection and final adjustments.
 - 2. Operational and functional checks of VFDs and spare parts.
 - 3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.
- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

- A. The Contractor shall provide a training session for one normal workday with a maximum of one trip. Training and instruction time shall be in addition to that required for start-up service. The

training shall be conducted by the manufacturer's qualified representative. The training program shall consist of the following:

1. Instructions on the proper operation of the equipment.
2. Instructions on the proper maintenance of the equipment.

END OF SECTION 23 09 01

SECTION 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for Mechanical"
 - 2. Section 23 09 00 – Instrumentation and Control for HVAC for control equipment and devices and submittal requirements.
 - 3. Division 23 – sections for HVAC equipment with digital controllers.
 - 4. Division 23 Section "Testing, Adjusting, and Balancing"
 - 5. Division 26

1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.
 - 1. Provide automatic control for system operation as described herein, although word "automatic" or "automatically", is not used.
 - 2. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.
 - 3. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.
- B. The system is BAS controlled using electric actuation. Provide proportional-integral-derivative (PID) algorithms for all control programs.
- C. Functions called for in sequence of operations are minimum requirements and not to limit additional BAS system capabilities. Determine, through operation of the system, proportional bands, interval time, integral periods, adjustment rates, and any other input information required to provide stable operation of the control programs.
- D. For each item of equipment, provide following functions which are not specifically mentioned in each Sequence of Operation:
 - 1. Start-Stop, manual, and scheduled
 - 2. On-Off status of each piece of equipment
 - 3. Run-time
 - 4. Alarm

- E. All setpoints shall be monitored and adjustable. Setpoints listed herein are approximate. It is the responsibility of the BAS contractor to calibrate the system and all setpoints to actual working conditions once the system is on line.

- F. Variable Frequency Drives
 - 1. Current VFD status and operating conditions shall be monitored through its communications interface port. The interface shall monitor the following software points: Motor RPM, motor amps, motor runtime, VFD status, "In fault condition", and "In bypass".
 - 2. System Dampers:
 - a. Damper control typically consists of a requirement to open a damper (such as an outdoor air damper, smoke damper, isolation damper, etc.) before the motor is to operate in any mode (drive or bypass). This means that a "start" or "run" command can come from the BAS, an operator at the VFD provides a local "start" command at the VFD keypad, or the command can come from the serial communication connection.
 - b. After a run command is received, but before the VFD actually runs the motor, the VFD shall close a relay contact to actuate the damper. When the damper is fully open, an end switch from the damper will close and then the VFD will be allowed to operate the motor. The damper end-switches shall be mounted such that they can be adjusted during start-up so the open indication is only provided when the damper is in the fully open position.
 - c. Ensure that the VFD has an input that when activated, will stop the motor in any VFD operating mode.

- G. Normal positions for controlled devices:
 - 1. Unless noted, the following valves and dampers shall fail closed:
 - a. Outside air dampers
 - b. Exhaust air closure dampers
 - c. Domestic hot water heat source.
 - 2. Unless noted, the following valves and dampers shall fail open:
 - a. Heating coils.

PART 2 - SEQUENCES OF OPERATION

2.1 BOILER PLANT CONTROL – CONDENSING BOILER PLANT

- A. Enable Boiler Plant: not wired to the BAS, enable the plant at the boiler plant controller, specified in Section 23 52 16. Each boiler shall run subject to its own internal safeties and controls.

- B. See F1 / MP5.0.

- C. Heating Primary Loop Control
 - 1. Input Device: Supply and return header temperature sensors shall be provided under Section 23 52 16.
 - 2. Action: Boiler plant shall be controlled by a Boiler Plant Controller specified in Section 23 52 16.
 - 3. Action: Provide boiler hot water to meet DHW heater demand. When the DHW demand is satisfied, boilers shall be controlled to provide heating hot water (temperature as per the reset schedule).
- D. Combustion air: Direct piped; combustion air damper control not required.
- E. Domestic Hot Water Recirculation Pumps: Wired to boiler plant controller.
- F. Heating-Water Supply Temperature Reset:
 - 1. Input Device: Outside air temperature wired to boiler plant controller
 - 2. Input Device: Provide heating main supply and main return temperature sensors.
 - 3. Output Device: boiler plant controller software, supply loop temperature setting.
 - 4. Action: Modulate the heating output to satisfy temperature setpoint.
- G. Enable: Heating hot water pumps, P-1A, P-1B
 - 1. Input Device: Boiler plant controller
 - 2. Output Device: boiler plant controller pump enable
 - 3. Action: Energize pump
 - 4. Pump Speed Control: Not controlled by BAS, pump speed control is built in to the self-sensing "smart" pumps specified in Section 23 21 23.
- H. Pump Status:
 - 1. Input Device: current sensor
 - 2. Output Device: BAS software
 - 3. Action: Generate an alarm if status deviates from BAS start/stop control.
 - 4. Action: Auto Lead Lag Pumps: Automatic lead-lag pump control is built in to the self-sensing "smart" pumps specified in Section 23 21 23. Lead pump shall rotate weekly to equalize run time.
- I. Heating Loop Minimum Flow:
 - 1. See unit heater schedule. Provide 3-way valves for selected unit heaters.
- J. Control DHW Heating Pumps:
 - 1. Input Device: DHW tank temperature sensors
 - 2. Output Device: boiler plant controller; contact closure to start pump.
 - 3. Action: Energize pump on a call for DHW heating. BAS shall provide auto lead-lag control of the DHW heating pumps. Lead pump shall rotate weekly to equalize run time.

- K. HW Temperature Monitoring – HW to building
 - 1. Input Device: Provide a temperature sensor in the domestic hot water supply pipe downstream of the thermostatic mixing valve (TMV).
 - 2. Output Device: BAS software.
 - 3. Action: TMV specified in Section 22 11 19 will mix the tank water with cold water to provide 120°F to the building. Monitor and alarm if the temperature exceeds 125°F for more than 20 minutes.

- L. Operator Station Display: Indicate the following on operator workstation display terminal:
 - 1. Outdoor-air temperature.
 - 2. Heating-water supply temperature.
 - 3. Heating-water supply temperature set point.
 - 4. Pump status, ON/OFF
 - 5. VFD status
 - 6. VFD fault
 - 7. Status of each boiler
 - 8. Mixed temperature to building, downstream of TMV.

2.2 PACKAGED ROOFTOP AC UNIT

- A. RTU-1 is supplied with factory-packaged controls. Provide all necessary monitoring points and additional control points to perform the following sequences defined for each unit.

- B. Occupied mode:
 - 1. Occupied mode shall be determined by a user defined occupancy schedule.
 - 2. System starts supply fan to run continuously. During occupied mode, the outside air damper shall open to its minimum position. Single zone variable volume control shall be packaged with the RTU.
 - 3. Gas Heating Stages: The packaged RTU controls shall operate the gas heating stages.
 - 4. Cooling Mode: Packaged RTU controls shall operate the mechanical cooling stages.
 - 5. Economizer cooling: Packaged RTU economizer controls.
 - 6. CO2 Demand Control: Packaged RTU control. BAS contractor shall install and wire the CO2 sensor in the duct.

- C. Unoccupied mode:
 - 1. OA, and EA dampers 100% closed, RA damper 100% open.
 - 2. Maintain a night setback (NSB) temperature of 65°F. Enable unit heating to maintain NSB temperature.
 - 3. Systems shall have 2 hour (adj.) unoccupied override ability.

- D. Safeties:
 - 1. Duct smoke detector (by Division 26): detector wired to the fire alarm system by the Electrical Contractor. Activated when products of combustion are detected in air stream, unit shall shut down.

- E. Display of input points thru BAS:
 - 1. System graphic
 - 2. System occupied/unoccupied mode.
 - 3. RTU status/failure: contact from RTU.
 - 4. Filter status: contact from RTU
 - 5. Discharge air temperature: analog output from RTU.
 - 6. Space temperature.

2.3 ENERGY RECOVERY UNITS

- A. Rooftop Energy Recovery Unit packaged gas heating and DX cooling – See Section 23 72 00.
 - 1. ERU-A: Serves housing areas; unit runs 24/7.
 - 2. ERU-B: User defined occupancy schedule. Unit shall be OFF during unoccupied cycle. BAS shall enable for occupied cycle.
 - 3. ERU'S to operate via their own factory installed controls.
 - 4. Provide wiring to thermostat that is furnished by 237200.
 - 5. Safety:
 - a. Duct smoke detector (by Division 26): detector wired to the fire alarm system by the Electrical Contractor. Activated when products of combustion are detected in air stream, unit shall shut down.
 - 6. BAS: Display the following data:
 - a. Monitor ERU alarm contact.

2.4 TERMINAL UNITS

- A. Unit Heaters
 - 1. Enable:
 - a. Input Device: BAS software
 - b. Output Device: BAS software
 - c. Action: Enable unit heaters whenever the boiler plant is in heating mode.
 - 2. Room Temperature:
 - a. Input Device: Electronic temperature sensor.
 - b. Output Device: BAS system binary output.
 - c. Output Device: Normally-open 2-position, 2-way control valve. Note: See unit heater schedule, some unit heaters will have 3-way valves, open/close.
 - d. Action: Open control valve and cycle fan to maintain space temperature (occupied & unoccupied). Minimum run time: 1 minute.
 - 1) Garage setpoint: 50°F.
 - 2) Other unit heater setpoints: 65°F.

B. Apartment Heating/Cooling – Fintube & Ductless Split

1. Provide a Honeywell T87N thermostat and mini-split adapter.
2. Thermostat shall control the fintube 2-position valve and ductless split in sequence.
3. Provide a deadband between heating and cooling.

C. Other Heating/Cooling – Fintube & Ductless Split

1. Provide a BAS temperature sensor and mini-split adapter.
2. Thermostat shall control the fintube 2-position valve and ductless split in sequence.
Note: Some zones are heating only.
3. Provide a deadband between heating and cooling.
4. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
5. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

2.5 EXHAUST FANS

A. Heat Relief

1. The fan shall be enabled after the damper status has proven.
2. The unit shall be continuously enabled to maintain a zone temperature cooling setpoint of 80°F (adj.).
3. The intake air damper shall open anytime the unit runs and shall close anytime the unit stops.
4. Alarms
 - a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Damper Failure: Commanded open, but the status is closed.

2.6 KITCHEN VENTILATION

A. Hood DCV controller is furnished by Division 11 with the kitchen hood. Provide control interface with the hood controller, EF-K, and MUA-1, and commission for proper operation. MUA-1 shall be energized any time EF-K is energized. Coordinate with Division 11 for a complete system.

1. The Demand Control Ventilation System (DCV) is provide by Division 11 with the kitchen hood. This system is designed to automatically reduce EF-K and MUA-1 supply airflow quantities, while ensuring hood performance is maintained. The DCV uses Variable Frequency Drives (VFD) and temperature sensors in the exhaust ducts to modulate the fans speed during cooking operation and maximize energy savings.
2. The system includes a LCD screen interface for fans and hood lights control, gas valve reset, programmable schedule, Max Air Override function, Preparation Time mode, Cool

Down mode, and diagnostics including VFD status. The LCD screen shows descriptive plain text explaining the functions or values.

3. The hood controller will constantly monitor the exhaust air temperature through the riser mounted temperature sensor and modulate the fan speeds accordingly.
 4. A room temperature sensor will be provided with the controller. The BAS contractor shall field installation in the kitchen space in order to start the fan based on the temperature differential between the room and the exhaust air in the duct rather than fixed set-points.
 5. Fan maximum/ minimum speeds will be adjustable for proper kitchen balance.
 6. Duct temperature sensor will be mounted in the exhaust hood riser. System will be factory pre-set to modulate fan speed within a range of 45°F for 600°F and 700°F cooking applications and a range of 5°F for 400°F cooking applications. Setpoints are fully adjustable through the touch screen interface based on application needs.
 7. The Max Air Override will have an adjustable timeout value.
 8. The panel is factory pre-wired to shut supply fans down in a fire condition. Options to turn ON the exhaust fans or turn off the hood lights in a fire condition will be configurable through the smart controller, but only through a password protected menu to prevent any changes after a fire inspection has been performed.
- B. Ansul R102 fire suppression and gas valve are provided by Division 11. Gas valve installed in gas pipe by Division 23.

2.7 ELEVATOR

- A. Elevator Damper: Provide a thermally-insulated low-leak motorized damper at top of elevator shaft (at louvers L-EA and L-EB). Damper shall be spring-open, power close. Damper shall be closed; upon signal from fire alarm system, damper shall open. In addition, provide a manual override control capable of opening and closing the vents. The control switch shall be labeled and located near the fire alarm control panel per PFD requirements.
- B. Elevator Sump Pump Alarm: Interlock sump pump alarm contact to BAS.

2.8 FIRE PUMP DIESEL TANK

- A. Monitor the leak detection alarm output, coordinate with Section 21 31 16.

2.9 GAS DETECTION

- A. All points shall be displayed thru the BAS.
- B. Carbon Monoxide (CO) Alarm & Natural Gas (CH₄) Alarm
1. BAS shall have program to schedule the sensor's replacement date (based on sensor service life for specific gas) and generate an alarm one month prior to this date.
 2. BAS shall alarm if limit reaches maximum setpoint for the following spaces:
 - a. Boiler Room
 - b. Bistro

C. Parking Garage

1. The system shall be arranged to operate automatically upon detection of vehicle operation by approved automatic detection devices. CO & NO₂ (diesel) exhaust detection and exhaust fan control shall be provided by a Macurco DVP-120 system.
2. Intake and exhaust dampers shall be thermally insulated.
3. When any CO sensor exceeds a threshold (ppm level in air) the following shall happen. The same sequence applies to the diesel sensor ppm levels.
 - a. Threshold # 1 (low alarm level trip/setpoint) at 25 ppm: Open the intake and exhaust dampers, prove open, and start the exhaust fan at minimum speed (25%) with relay #1 to bring in fresh air and reduce the CO level.
 - b. Threshold # 2 (medium alarm level trip/setpoint) at 75 ppm: Use the analog output associated with this exhaust fan to ramp up the VFD between 25 ppm and 75 ppm proportionally to highest speed.
 - c. Threshold # 3 (high alarm level trip/setpoint) at 100 ppm: Turn on with relay remote horns/strobes located in garage area or areas where security or maintenance personnel can be warned of high ppm CO concentration; alarm the BAS.
4. Heat Relief
 - a. The fan shall be enabled after the dampers have proven open.
 - b. The exhaust fan shall be continuously enabled to maintain a zone temperature cooling setpoint of 80°F (adj.). Modulate EF fan speed.
 - c. The intake/exhaust air dampers shall open anytime the unit runs and shall close anytime the unit stops.
 - d. Outside air intake duct smoke detector (by Division 26): detector wired to the fire alarm system by the Electrical Contractor. Activated when products of combustion are detected in air stream; turn off EF.
 - e. Alarm: High zone temperature.

END OF SECTION 23 09 93

SECTION 23 11 23 – FACILITY FUEL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 31 Sections.
 - 2. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 3. Division 23 Section "Common Work Results for HVAC"
 - 4. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.

1.2 SUMMARY

- A. This Section includes fuel gas piping, specialties, and accessories within the building.

1.3 PROJECT CONDITIONS

- A. Gas System Pressure: Coordinate with gas supplier.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Corrugated, stainless-steel tubing systems. Include associated components.
 - 2. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Service meter and accessories.
 - 4. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
 - 5. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Maintenance Data: For natural gas specialties and accessories to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

- A. All work shall be performed by technicians holding a Maine Propane and Natural Gas Technician License: "Large Equipment Connection and Service Technician"
- B. Installations of natural gas must also comply with all other applicable statutes or rules of the State and all applicable ordinances, orders, rules, and regulations of local municipalities.
- C. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. All work shall be per the following codes. Year edition of code shall be as recognized by the authority with jurisdiction
 - 1. NFPA 54 "National Fuel Gas Code".
 - 2. NFPA 30, Flammable and Combustible Liquids Code
 - 3. NFPA 211, Chimneys, Fireplaces, Vents, and Solid Fuel Appliances
- E. FM Standard: Provide components listed in FM's "Fire Protection Approval Guide" if specified to be FM approved.
- F. Comply with the Maine Fuel Board Laws and Rules.
- G. IAS Standard: Provide components listed in IAS's "Directory of A. G. A. and C. G. A Certified Appliances and Accessories" if specified to be IAS listed.
- H. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.
- I. American Society of Mechanical Engineers (ASME) Code CSD-1 Controls and Safety Devices for Automatically Fired Boilers, 2002 edition

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

- A. Make arrangements with local utility for gas service to the Owner's distribution system. Provide service to the building as required by the Utility Company. Coordinate all activities between the Owner and Utility Company. The installation of the gas service shall comply with the published Utility Company standards. Pay all utility company charges; include charges in the base bid.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Corrugated, Stainless-Steel Tubing Systems:

- a. Omega Flex, Inc.
- b. Titeflex Corp.
- c. Tru-Flex Metal Hose Corp.
- d. Ward Manufacturing, Inc.

2. Valves:

- a. American Valve.
- b. B&K Industries, Inc.
- c. Brass Craft Manufacturing Co.
- d. Conbraco Industries, Inc.; Apollo Div.
- e. Crane Valves.
- f. Grinnell Corp.
- g. Honeywell, Inc.
- h. Key Gas Components, Inc.
- i. McDonald: A. Y. McDonald Mfg. Co.
- j. Milwaukee Valve Co., Inc.
- k. Nibco, Inc.
- l. Mueller Co.; Mueller Gas Products Div.
- m. Watts Industries, Inc.

3. Pressure Regulators:

- a. American Meter Co.
- b. Equimeter, Inc.
- c. Fisher Controls International, Inc.
- d. Maxitrol Co.
- e. National Meter.
- f. Richards Industries, Inc.; Jordan Valve Div.
- g. Schlumberger Industries; Gas Div.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

- A. Steel Pipe: ASTM A 106, ANSI/ASME B36.10, ASTM A 53; Grade B; Schedule 40; black.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
 - 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
 - 3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
 - 4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
 - 5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
 - 6. Joint Compound and Tape: Suitable for natural gas.
 - 7. Steel Flanges and Flanged Fittings: ASME B16.5.
 - 8. Gasket Material: Thickness, material, and type suitable for natural gas.
- B. Corrugated Stainless Steel Tubing Systems: Gastite or approved equal; a corrugated stainless steel tubing complying with ANSI LC 1b "Fuel Gas Piping Systems Using CSST" and listed with CSA[®], ICBO and IAPMO. Manufacturing materials shall be: ASTM A240 type 300 corrugated stainless steel tubing with a minimum wall thickness of .010", jacketing of UV resistant polyethylene meeting the requirements of ASTM E84 for flame spread and smoke density. All mechanical tube fittings shall be SAE CA360 brass incorporating double wall flare sealing and Jacket Lock[®] jacket capturing for steel tubing protection.
 - 1. Striker Plates: Steel, designed to protect tubing from penetrations.
 - 2. Manifolds: Malleable iron or steel with protective coating. Include threaded connections according to ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
- C. Transition Fittings: Type, material, and end connections to match piping being joined.
- D. Common Joining Materials: Refer to Division 23 Section "Common Work Results for HVAC" for joining materials not in this Section.

2.4 PIPING SPECIALTIES

- A. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.
- B. Pressure gages shall conform to ASME B40.100, Type I, Class 1. Pressure-gage size shall be 3-1/2-inch nominal diameter. Case shall be corrosion-resistant steel conforming to any of the AISI 300 series of ASTM A 666, with a No. 4 standard commercial polish or better. All gages shall be equipped with adjustable red marking pointer and damper screw adjustment in inlet connection.

2.5 SPECIALTY VALVES

- A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

- C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.
- D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
- E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating. Tamperproof Feature: Include design for locking.
- F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating. Tamperproof Feature: Include design for locking.
- G. General-Duty Valves, NPS 2-1/2 and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125-psig pressure rating.
 - 1. Gate Valves: MSS SP-70, OS&Y type with solid wedge.
 - 2. Butterfly Valves: MSS SP-67, lug type with lever handle.

2.6 NATURAL GAS SERVICE METER AND PRESSURE REGULATOR

- A. Natural Gas Service Meter: Provided by gas supplier. Coordinate requirements and pay all fees and costs.

2.7 PRESSURE REGULATORS

- A. Regulators may include vent limiting device, instead of vent connection to outside, if approved by authorities having jurisdiction. Provide venting as required by code.
- B. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.
- C. Appliance Pressure Regulators: ANSI Z21.18.
- D. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.
- B. Comply with ANSI Z223.1, "Prevention of Accidental Ignition" Paragraph.

3.2 SERVICE ENTRANCE PIPING

- A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.
- B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Refer to Division 23 Section "Common Work Results for HVAC" for dielectric fittings.

3.3 PIPING APPLICATIONS

- A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.
- B. Fuel Gas Piping: Use the following:
 - 1. NPS 1 and Smaller: steel pipe, malleable-iron threaded fittings, and threaded joints. Option: Corrugated, stainless-steel tubing may be used for runouts at individual appliances.
 - 2. NPS 1-1/4 to NPS 2: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 3. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.
- C. In-slab (within building) Fuel Gas Piping: not permitted
- D. Commercial Cooking Appliances. Commercial cooking appliances shall be connected in accordance with the connector manufacturer's installation instructions using a listed appliance connector complying with ANSI Z21.69, Connectors for Moveable Gas Appliances.
 - 1. Division 23 shall be responsible for the mounting of the gas shut-off valve (provided by Division 11) at an appropriate location on the gas line.

3.4 VALVE APPLICATIONS

- A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.
- B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.
- C. Piping Line Valves, NPS 2 and Smaller: Gas valve.
- D. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.
- E. Valves at Service Meter, NPS 2 and Smaller: Gas valve.
- F. Valves at Service Meter, NPS 2-1/2 and Larger: Plug valve.

3.5 PIPING INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for HVAC" for basic piping installation requirements.
1. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
 2. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.
 3. Install fuel gas piping at uniform grade of $\frac{1}{4}$ " per 15 feet.
 4. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
 5. Connect branch piping from top or side of horizontal piping.
 6. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
 7. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
 8. Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.
 9. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
 10. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
 11. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.
- B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
 2. In Floors: not permitted.
 3. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls. Exception: Tubing passing through partitions or walls.
 4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or elevator shafts. Exception: Accessible above-ceiling space specified above.

3.6 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."
- B. Support gas piping in accordance with NFPA 54. Steel pipe spacing of supports: ½" pipe = 6 feet; ¾" or 1" = 8 feet; 1-1/4" and larger = 10 feet.
- C. Support horizontal corrugated, stainless-steel tubing from structure according to manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.
- B. Install piping adjacent to appliances to allow service and maintenance.
- C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
- D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.8 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
 - 1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 - 2. Refer to Division 23 Section "Identification for HVAC" for nameplates and signs.

3.9 PAINTING

- A. Use materials and procedures in Division 9 Section "Painting," "Exterior Paint Schedule" Article, "Ferrous Metal" Paragraph, "Full-Gloss, Alkyd-Enamel Finish" Subparagraph.
- B. Paint exterior piping, service meters, pressure regulators, and specialty valves. Color: as per Architect.
- C. Paint all exterior metal support brackets for piping. Color: as per Architect.

3.10 FIELD QUALITY CONTROL

- A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.

- B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
- C. Report test results promptly and in writing to Architect and authorities having jurisdiction.
- D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.
- E. Verify correct pressure settings for pressure regulators.
- F. Verify that specified piping tests are complete.
- G. Verify that the gas piping has been grounded by Division 16 in accordance with NFPA requirements.

3.11 ADJUSTING

- A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 23 11 23

SECTION 23 21 13 – HYDRONIC HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Common Work Results for Mechanical"
 - 3. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.
 - 4. Division 23 Section "Thermometers and Pressure Gages"
 - 5. Division 23 Section "Mechanical Identification" for labeling and identifying hydronic piping.
 - 6. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
 - 7. Division 23 controls section for temperature-control valves and sensors.

1.2 SUMMARY

- A. This Section includes HVAC piping and specialties.

1.3 SUBMITTALS

- A. Product Data: Provide manufacturer's standard submittal cut sheets. For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- C. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Qualify soldering processes, procedures, and solderers for copper and copper alloy pipe and tube in accordance with ASTM B 828.
- C. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.5 COORDINATION

- A. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.
- B. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- C. Coordinate pipe sleeve installations for foundation wall penetrations.
- D. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.
- E. Coordinate pipe fitting pressure classes with products specified in related Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Refer to Division 23 Section "Common Work Results for Mechanical".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Balancing Valves:
 - a. Griswold Controls.
 - b. ITT Bell & Gossett
 - c. Taco, Inc.
 - d. Tour & Anderson

- e. Flow Design, Inc.
 - f. Griswold Controls
 - g. Watts Industries Inc.
2. Hydronic Pressure-Reducing Valves:
- a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT Bell & Gossett
 - e. Spence Engineering Company, Inc.
 - f. Watts Industries, Inc.
3. Safety Valves:
- a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT McDonnell & Miller.
 - e. Kunkle Valve Division.
 - f. Spence Engineering Company, Inc.
 - g. Watts Industries Inc.
4. Expansion Tanks, Air Separators, and Hydronic Specialties:
- a. Amtrol, Inc.
 - b. Woods
 - c. ITT Bell & Gossett
 - d. Taco, Inc.
 - e. Aurora
 - f. Watts Industries Inc.
5. Air Vents and Vacuum Breakers:
- a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. ITT Hoffman
 - d. Johnson Corp. (The).
 - e. Spirax Sarco, Inc.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A-53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40 and 80, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 and larger: ASTM A-53, Type E (electric-resistance welded), Grade B, Schedule 40 and 80, black steel, plain ends.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- F. Wrought-Steel Fittings: ASTM A-234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt-welding.
 - 3. Facings: Raised face.
- H. Mechanically formed copper or steel tee connections are not acceptable.
- I. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and thredolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ANSI B16.11 may be used for drain, vent and gage connections.
- J. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

- K. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 AQUATHERM PIPING

- A. Pipe shall be Aquatherm Climatherm or Climatherm Faser, available from Aquatherm, Inc. Hot water supply piping shall contain a fiber layer (faser) to restrict thermal expansion.
- B. As proof of Aquatherm's demanding quality standards, all properly installed Aquatherm pipe systems carry a 10-year warranty for property damage liability coverage of up to \$15 million per damage event. This warranty covers the pipes, the fittings, and any incidental damage caused by material failure. The policy also provides an additional \$15 million for personal injury.
- C. Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in a three layer extrusion process. All pipe shall comply with the rated pressure requirements of ASTM F 2389. All pipe shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.
- D. Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
- E. Where indicated on the drawings that a Plenum-rated Piping System is needed, then the pipe shall be pre-insulated or field insulated, and when tested with standard un-insulated fittings per CAN/ULC-S102.2-03 or ASTM E84, the system consisting of wrapped or coated pipe and bare fittings shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.
- F. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a Factory applied, UV-resistant coating or alternative UV protection.
- G. When installed in systems with pumps in excess of 7.5 HP, piping shall be protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method shall be a temperature relief valve or comparable level of protection, set to a maximum temperature of 185°F.
- H. If heat tracing is specified for the piping, it should be installed on the pipe interior or exterior, and it must be suitable for use with plastic piping and self-regulating to ensure the surface temperature of the pipe and fittings will not exceed 70°C (158°F).
- I. Where up to 1 inch of standard insulation is indicated in Section 23 07 00, a factory installed, thermal (radiant, conductive, and convective) and vapour barrier insulation shall be provided. Where more than 1 inch of standard insulation is indicated in Section 23 07 00, additional overlap of factory installed, thermal (radiant, conductive, and convective) and vapour barrier

insulation shall be provided to ensure equivalent thermal resistance. The thick wall, self insulating fittings do not require an additional vapour barrier for the piping system to meet this performance level. The thermal barrier is UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth. The pipe with the integral thermal barrier with standard unprotected fittings shall meet the ASTM E84 and the CAN/ULC S102.2 requirements for a Flame Spread Rating of 25 and Smoke Development rating of 50.

- J. Manufacturer shall warrant pipe and fittings for 10 years to be free of defects in materials or workmanship. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system do to defects in materials or workmanship.

2.6 PVC PIPE AND FITTINGS

- A. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D 1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Fittings shall conform to ASTM D 2665.

2.7 PEX PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. PEX-a manufacturer system warranty shall cover tubing for a duration of 30 years from the date of installation.
 - 1. Uponor Wirsbo hePEX (Basis of Design)
 - 2. Rehau
 - 3. Mr. PEX
- B. PEX-a (Engle-method Crosslinked Polyethylene) Piping: ASTM 876 with oxygen-diffusion barrier that meets DIN 4726. Performance Requirements: 200°F at 80 psi, 180°F at 100 psi.
- C. PEX-a Fittings, Elbows and Tees (½ inch through 2 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
 - 1. UNS No. C69300 Lead-free (LF) Brass
 - 2. 20% glass-filled polysulfone as specified in ASTM D6394
 - 3. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394
 - 4. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
 - 5. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394
 - 6. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".
- D. PEX-a Fittings (2½ inch through 4 inch nominal pipe size): SDR9 compression type fitting consisting of a double O-ring insert with a compression sleeve tightened around the pipe and insert.

E. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. 2" and below: Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
3. 2-1/2" to 4": Dezincification-resistant (DZR) Brass to PEX-a Transition: male NPT thread and PEX compression fitting.

F. Plastic-to-Metal Transition Unions:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. Threaded Brass to PEX-a Union: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
3. Brass Sweat to PEX-a Union: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

G. Insulation: PEX runout piping shall be pre-insulated or field insulated, mechanical contractor option. Coordinate with Section 230700. Insulation thicknesses per Section 230700.

2.8 HYDRONIC VALVES

A. Ball Valves

1. Threaded Ends 4" and Smaller: 150 psi WP and 600psi non-shock CWP, forged brass full-port or cast bronze two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBV-3C series/B6080 series, Hammond 8501, Nibco T-585-70, Milwaukee BA100, Apollo 70-Series, or approved equal.
2. Soldered Ends 3" and Smaller: 150 psi WP and 600psi non-shock CWP, full-port cast bronze or forged brass two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBVS-3C series/B6081 series, Hammond 8511, Nibco S-585-70, Milwaukee BA150, Apollo 70-Series, approved or equal.
3. Aquatherm Climatherm: Valves shall be manufactured in accordance with the manufacturer's specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
4. Comply with MSS SP-110.

B. Butterfly Valves

1. Basis of Design: Center Line Series 200; Lug Type, cast iron, drilled and tapped lug body, ductile iron disc, 416SS shaft, bronze bushing, EPDM seat.
2. Valve bodies shall have extended necks to provide for 2-1/4" insulation as needed.
3. Comply with MSS SP-67.

4. Compatible with ANSI 125/150 flanges. Dead-end capacity to 200 psi.
 5. Operators: 6" and smaller: handle with infinite adjustment; 8" and larger: gear w/balance-stop hand wheel. Valves located 7 feet or higher: provide gear/chain wheel.
 6. Approved Manufacturers: Watts, Hammond, Nibco, Milwaukee, or approved equal.
- C. Wafer Check valves: Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between two standard Class 125 flanges. Construct iron body valves with pressure containing parts of valves with materials conforming to ANSI/ASTM A 126, Grade B. Support hanger pin by removable side plug; Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal; Watts BF/DBF series, Metraflex 700 Series, Nibco W920-W, Stockham WG970, Hammond 9253, Milwaukee 1400, or approved or equal.
- D. Swing check valves:
1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B
 2. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71.
 3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
 4. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413Y, Stockham B320T, Milwaukee 509 or approved equal.
 5. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-Y, Stockham B310T, Milwaukee 511 or approved equal.
 6. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Hammond IR1124, Nibco F918-B, Stockham G931, Milwaukee F2974 or approved equal.
- E. Calibrated Balancing Valves, Watts CSM-61/81 series, Taco Accu-Flo, or approved equal.
1. Accuracy 4-5 times greater than variable orifice balancing valves.
 2. Flow measurement independent of stem and ball position.
 3. Calibrated nameplate: Easy to read. Memory stop is tamper resistant and has a fast and accurate resetting if shut-off feature is used. Calibrated to aid in pre-balancing flow loop.
 4. Tamper resistant memory- stop for accurate resetting; positive shut-off; ability to read low flows.
 5. Schrader style pressure ports
 6. Bronze Body rated to: 300 PSI, 250°F;
 7. Cast Iron Body: Class 125
 8. Modified venturi design; blowout-proof stem held secure by valve body; ball valve construction with Teflon seats; built-in drain port; all brass interior parts.
 9. Provide a closed cell polyethylene foam insulation kit with each valve.
- F. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.
- G. ASME Safety Relief Valves: Bell & Gossett A-434D, or equal; diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

The fluid shall not discharge into the spring chamber. The valve shall have a low blow-down differential. The valve seat and all moving parts exposed to the fluid shall be of non-ferrous material.

2.9 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.
- B. Automatic Air Vent: designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection. Seton, Brady, or approved equal.
- C. Expansion Tanks: Taco Model CA, or approved equal. Construction: Welded steel, designed, tested and stamped in accordance with ASME (BPV code sec VIII, div 1); supplied with National Board Form U-1, rated for working pressure of (125/150 psi), with flexible heavy duty butyl rubber bladder. Bladder shall be able to accept the full volume of the expansion tank and shall be removable and replaceable. Bladder shall be NSF 61 rated for potable water service and shall be manufactured with FDA approved materials.
 - 1. Expansion tank isolation valves: Provide valve lockouts: shall meet OSHA requirements to ensure ball valves are locked securely and effectively; for use on 1/4-turn valves to prevent tampering; polypropylene material resists chemicals, solvents, cracking & rust; provide padlock locking mechanism. Seton, Brady, or approved equal.
 - 2. Accessories: Pressure gage (field installed by others) and air-charging fitting.
 - 3. Automatic Cold Water Fill Assembly (field installed by others): Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
- D. Air and Dirt Separator
 - 1. Furnish and install air and dirt removal device(s) of the size and type as shown on the plans. Air and dirt separation devices shall be Taco 4900 Series or approved equal by Spirovent or Bell & Gossett.
 - 2. Air and dirt removal device shall be constructed of steel designed and fabricated per Section VIII Division 1 of the A.S.M.E. Boiler and Pressure Vessel Code with a maximum working pressure rating of (125 / 150) psi at 270°F. Units up to 3 inch in size shall be provided with (threaded / flanged) system connections. Units 4 inch and larger shall be provided with flanged system connections as standard.
 - 3. Each air & dirt separator shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. Air vent shall be furnished with a closeable port to prevent vent clogging during system fill. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and the removal of floating impurities from the air / system fluid interface within the separator. A blowdown valve shall be provided by the unit manufacturer on the bottom of each air and dirt separator to allow cleaning as required.
 - 4. The air & dirt separator shall employ the use of high surface area, stainless steel pall rings to achieve optimal separation of (air / air & dirt) from the system fluid. Screens made of 304-stainless steel are provided on the inlet and outlet of each separator to

- isolate the internals from the system. Units installed in open systems shall be provided with a removable top head for removal and cleaning of the internal coalescence media.
5. The supplier of the air & dirt separator shall furnish to the design engineer the results of independent air & dirt testing of a representative unit from the suppliers' standard product offering. Suppliers not providing these independent performance test results will not be accepted.
- E. Bypass Chemical Feeder: Neptune Model DBF, J. L. Wingert Company, or approved equal; welded steel construction; rated for 300 psi at 180°F; 5-gallon capacity; with 4" fill cap; and inlet, outlet, and drain valves.
1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- F. Y-Pattern Strainers: Strainers shall be Y-type with removable basket. Body shall have cast-in arrows to indicate direction of flow. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 corrosion-resistant steel. Provide fine-mesh start-up strainers.
1. Strainers in sizes 3-inch and smaller shall have screwed ends; Hammond 3010, or approved equal. Body material shall be cast bronze conforming to ASTM B584-C84400. Strainer bodies fitted with screwed screen retainers shall have straight threads and shall be gasketed with nonferrous metal. Strainer screens shall have perforations not to exceed 1/32".
 2. In sizes 4 and larger, strainers shall have flanged ends; Hammond 3030, or approved equal. Body material shall be cast iron conforming to ASTM A126 Class B. Strainer bodies fitted with bolted-on screen retainers shall have offset blowdown holes. Strainer screens shall have perforations not to exceed 1/16" (4" size); 1/8" (5" size and larger).

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS – ABOVE GROUND

- A. Hot Water, NPS 2 and Smaller: Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints; PEX-a piping with F1960 cold-expansion fittings.
- B. Hot Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded or welded and flanged joints.
- C. Hot Water: Aquatherm Climatherm fiber-composite SDR 11 pipes are rated for 100 psi at 180 degrees F. Low temperature hot water systems (design HWS temp of 160°F or lower) may use Aquatherm.
- D. Makeup water piping, downstream of backflow preventer: Aquatherm or Type L, drawn-temper copper tubing; PEX-a piping, with F1960 cold-expansion fittings.
- E. Drain Lines, indoors: 3/4" minimum diameter; PVC or DWV Copper Tubing: ASTM B 306, Type DWV.

- F. Drain Lines, RTU or ERU: PVC

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow.

3.3 VALVE APPLICATIONS

- A. Hydronic Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Ball and butterfly valves.
 - 2. Throttling Duty: Globe, ball, and butterfly valves.
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of terminal units [as indicated] [as required to facilitate system balancing].
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.4 HYDRONIC PIPING INSTALLATIONS

- A. Refer to Division 23 Section "Common Work Results for Mechanical" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Refer to Division 23 Section "Common Work Results for Mechanical" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

D. Fusion Welded Aquatherm Joints:

1. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting type. All fusion-well joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
2. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
3. Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389 and the manufacturer's specifications.
4. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

E. PEX Piping

1. Install PEX-a tubing according to manufacturer's recommendations.
2. PEX-a Piping Hanger Spacing: Install hangers for PEX-a piping with the following maximum spacing:
 - a. 1 inch and below: Maximum span, 32 inches.
 - b. 1¼ inch and above: Maximum span, 48 inches.
 - c. PEX-a Piping Hanger Spacing with PEX-a Support Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations, with the following maximum spacing: Maximum span, 8 feet.
3. PEX-a Riser Supports: Install CTS riser clamps at the base of each floor and at the top of every other floor. Install mid-story guides between each floor.
4. Pipe Joint Construction: PEX-a Connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for F1960 connections.

F. Hydronic piping systems shall be provided to permit the system to be drained. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and hose-end fitting with cap, at low points in piping system mains and elsewhere as required for system drainage.

G. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

H. Pipe size at connections to equipment shall be distribution main size, not connection size.

I. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

J. Provide dielectric fittings as specified in Section 23 05 00.

K. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

L. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

- M. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, and elsewhere as indicated or recommended by component manufacturer to have strainer protection.
 - 1. Provide valved drain and hose connection on strainer blow down connection.
 - 2. Install with provisions for service clearance.
 - 3. Remove and clean strainer after 24 hours of operation and after 30 days of operation.

3.5 SAFETY VALVE INSTALLATIONS

- A. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.
- B. Check the settings and operation of each safety valve, including valves furnished by heater manufacturer. Record settings.

3.6 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

3.7 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- B. Air separator and expansion tank to be installed on the suction side of the system pumps. Expansion tank to be tied into system piping in close proximity to air separator and system fill line. Install piping to expansion tank with a 2 percent upward slope toward tank.
- C. Install expansion tanks on concrete pad. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements. Do not install drain valve.

3.8 CONTROL VALVE INSTALLATION

- A. Perform the following as directed by the BAS contractor:
 - 1. Install modulating control valves with minimum of 10 pipe diameters straight pipe at inlet and 5 pipe diameters straight pipe at outlet.
 - 2. Installation of immersion wells and pressure tapplings, along with associated shut-off cocks.
 - 3. Installation of flow switches.
 - 4. Setting of automatic control valves or other control devices.

- B. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- C. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- D. Valves shall be installed in accordance with the manufacturer's recommendations.
- E. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- F. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.

3.9 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Arrange piping with offsets to allow for expansion, as well as terminal unit removal.

3.10 CLEANING AND FLUSHING

- A. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet/second if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean.
- B. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.
- C. Close and fill system as soon as possible after final flushing to minimize corrosion.

D. Chemical Treatment

1. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.
2. Fill system and perform initial chemical treatment.
3. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
4. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

3.11 FIELD QUALITY CONTROL

A. Prepare piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, un-insulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure but not less than 100 psi. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix-A of ASME B31.9, "Building Services Piping."
4. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
5. Prepare written report of testing.

C. Check expansion tanks to determine that they are not air bound and that system is full of water.

3.12 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
 - 1. Open valves to fully open position.
 - 2. Check pump for proper direction of rotation.
 - 3. Set automatic fill valves for required system pressure.
 - 4. Check air vents at high points of system and determine if all are installed and operating and bleed air completely.
 - 5. Set temperature controls so all coils are calling for full flow.
 - 6. Check operation of automatic bypass valves.
 - 7. Lubricate motors and bearings.

3.13 CLEANING

- A. Flush piping systems with clean water.
- B. Remove and clean or replace strainer screens.
- C. After cleaning and flushing hydronic-piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers, and replace with the permanent stainless steel screens.

END OF SECTION 23 21 13

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY

- A. This Section includes hydronic pumps and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pump. 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. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

- A. Concrete Bases: Refer to Section 23 05 00.
- B. Coordinate electrical power with Division 26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Taco
 - 2. Armstrong
 - 3. Bell & Gossett ITT
 - 4. PACO
 - 5. Grundfos
 - 6. Patterson
 - 7. Wilo

2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve.
- C. Motors Indicated to be premium efficiency: Refer to Section 23 05 00 for minimum efficiencies.
- D. Motors shall be inverter duty.
- E. Provide AEGIS® Shaft Grounding Ring (SGR) on either DE or NDE of motor to divert current away from the bearings and protect bearings in attached equipment.

2.3 VERTICAL PUMPS

- A. Furnish and install centrifugal in-line single stage pumps with capacities and characteristics as shown on the plans.
- B. Vertical Close Coupled Pumps.
 - 1. Pumps shall be Taco Model KV or approved equal. The pumps shall be single stage end suction rear pull out design. The seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.
 - 2. Pump casing shall be constructed of ASTM-A48 class-30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.
 - 3. All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided with that pump to allow servicing.
 - 4. The pump shall have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.
 - 5. The impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.
 - 6. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable bronze SAE 660 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.
 - 7. The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. The entire pump line shall use no more than three different sizes of seals.
 - 8. The pump shall be close coupled to a NEMA standard JM frame motor

2.4 SELF SENSING INLINE PUMPS

- A. Taco, Inc. – SKV Self-Sensing Series with ProBalance. The self-sensing product shall consist of a factory prepackaged and preprogrammed pump, drive, motor, and integral controls package.

B. General

1. The drive shall be mounted and integral to the motor. It shall be mounted with rubber vibration mounts. The mounting and packing of the drive shall be done in a manner that transmitted acceleration levels will be three times below the allowable limits published by the drive manufacturer. These limits will apply to a frequency range of 0-10,000 HZ.
2. The performance speed of this package shall 1750 RPM nominal as standard. Exceptions for 3600 RPM will be noted in the schedules. 3600 RPM shall NOT be an allowable substitution for a specified 1750 RPM package. 3600 RPM products might be considered as a substitution for 1750 RPM only if that manufacturer provides a spare motor, drive, and seal for each pumping unit.
3. Pump logic controller, variable frequency drives, sensor/transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

C. Pump construction – same as Model KV.

D. Stand – provide stand for base mounting.

E. Pump Logic Controller.

1. The controller operation shall operate the system using a tested and proven program that safeguards against undesirable or damaging conditions including:
 2. Motor overload
 3. Pump flow surges
 4. Hydraulic cycling (hunting).
 5. End of curve unstable operation: The pump logic controller, through a factory pre-programmed algorithm, shall be capable of protecting the pumps from hydraulic damage due to operation beyond their published end-of-curve. This feature requires a flow meter for activation. The operator interface shall include an owner adjustable flow set point to set the parameters for this routine.
 6. The pump logic controller shall be capable of starting, unloading, and stopping pumps based on a system performance program that will minimize energy consumption, provide reliable performance and bumpless transitions.
 7. The integrated logic controller shall provide the following hydronic optimization sub-routines
 - a. Setup one: This subroutine shall allow the pump package to track a quadratic system curve and will optimize a secondary distribution loop. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
 - b. Setup two: This subroutine shall allow two pumps to run as backup for each other and shall alternate the pumps based on a real time clock.
8. The control platform shall include a subroutine equal to the Taco Self-Sensing Series with ProBalance™. This subroutine shall allow for the automatic balancing of secondary system distribution pumps. The package shall automatically run system distribution pumps to a user defined duty point and will recognize that duty point and hold the pumps at a speed that matches the actual installed system quadratic system curve. The package will then use this data to set up a new duty point as the max point for the quadratic control curve. Use of external balancing devices or contractors will not be needed.

9. The package shall serve as a flow metering device and will display pump flow at the user interface.

F. Variable Frequency Drives

1. The VFD shall convert incoming fixed frequency three-phase ac power into an adjustable frequency and voltage for controlling the speed of three-phase ac motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
 - a. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
 - b. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the dc bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) dc link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
 - c. The VFD's full load output current rating shall meet or exceed NEC table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
 - d. The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.
 - e. A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
 - f. The VFD must be able to produce full torque at low speed to operate direct drive fans.
 - g. Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
 - h. An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
 - i. Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.
 - j. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to

optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

- k. All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the ac power line.
- l. The drive enclosure shall be standard as NEMA 12 (Ip 55) and optional shall be NEMA 4X (Ip 66). See schedules for project requirements.
- m. Protective features
 - 1) A minimum of class 20 i2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
 - a) Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.
 - b) Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
 - c) Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
 - d) Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.
 - e) The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.
 - f) VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.
 - g) VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.
 - h) VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.
 - i) Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.
 - j) VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

- k) If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.
- l) In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
- m) The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.
- n) The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.
- o) When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2. Internal Control Algorithm

- a. This is a standard HVAC drive that has been upgraded and modified by pump experts for hydronic applications. It is set up with a closed loop internal control sequence that will optimize life cycle, system comfort, and minimize energy consumption.

3. Interface Features

- a. Hand, off and auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
 - 1) There shall be an "info" key on the keypad. The info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
 - 2) The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in hand or auto mode. This is to alert the building automation system whether the VFD is being controlled locally or by the building automation system.
 - 3) Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
 - 4) All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
 - 5) To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

- 6) Display shall be programmable to communicate in multiple languages including English, Spanish and French.
 - 7) A red fault light, a yellow warning light and a green power-on light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
 - 8) A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual fan, pump, and compressor menus specifically designed to facilitate start-up of these applications.
- b. A four-feedback PID controller to control the speed of the VFD shall be standard.
 - c. This controller shall accept up to four feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
 - d. The VFD shall be able to apply individual scaling to each feedback signal.
 - e. The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
 - f. The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
 - g. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
 - h. Five simultaneous meter displays shall be available. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.
 - i. Programmable sleep mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into sleep mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
 - j. A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.
 - k. VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).
 - l. VFD shall be programmable to sense the loss of load and signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

4. Standard Control And Monitoring Inputs And Outputs
 - a. Six dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
 - b. Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
 - c. Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
 - d. Each relay shall have an adjustable on delay / off delay time.
 - e. Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
 - f. Each shall be independently selectable to be used with either an analog voltage or current signal.
 - g. The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
 - h. A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
 - i. The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting.
 - j. One programmable analog current output (4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
 - k. It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
 - l. It shall be possible to command all digital and analog output through the serial communication bus.

5. Optional Control And Monitoring Inputs And Outputs
 - a. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
 - b. These modules shall use rigid connectors to plug into the VFD's control card.
 - c. The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
 - d. Modules may include such items as:
 - e. Additional digital outputs, including relay outputs
 - f. Additional digital inputs
 - g. Additional analog outputs
 - h. Additional analog inputs, including Ni or Pt temperature sensor inputs
 - i. It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

6. A real-time clock shall be an integral part of the VFD.
 - a. It shall be possible to use this to display the current date and time on the VFD's display.
 - b. Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is

- shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
- c. All VFD faults shall be time stamped to aid troubleshooting.
 - d. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
 - e. The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
 - f. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
7. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
- a. Comparators for comparing VFD analog values to programmed trigger values
 - b. Logic operators to combine up to three logic expressions using Boolean algebra
 - c. Delay timers
 - d. A 20-step programmable structure
8. The VFD shall include a cascade controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.
- a. Serial communications: The VFD shall include a standard eia-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
 - 1) Johnson Controls Metasys N2
 - 2) Modbus RTU
 - 3) Siemens FLN
 - 4) BACnet MS/TP
 - b. Optional communication shall include: LonWorks Free Topology (FTP)
 - c. VFD shall have standard RS-485 port for direct connection of personal computer (PC) to the VFD. The manufacturer shall provide no-charge pc software to allow complete setup and access of the VFD and logs of VFD operation through the rs-485 port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.
 - d. The VFD shall have provisions for an optional 24 v DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.
9. Adjustments
- a. The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
 - b. Four independent setups shall be provided.
 - c. Four preset speeds per setup shall be provided for a total of 16.

- d. Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.
 - e. Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.
 - f. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
 - g. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
 - h. An automatic “start delay” may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
 - i. Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.
10. Optional features
- a. All optional features shall be built and mounted by VFD manufacturer. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.
 - b. All panels shall be marked for their short circuit current rating in compliance with UL.
11. Service conditions
- a. Ambient temperature, continuous, full speed, full load operation:
 - b. 14°F to 113°F
 - c. 0 to 95% relative humidity, non-condensing.
 - d. Elevation to 3,300 feet without de-rating.
 - e. AC line voltage variation, -10 to +10% of nominal with full output.
 - f. No side clearance shall be required for cooling.
 - g. All power and control wiring shall be done from the bottom.
 - h. All VFDs shall be plenum rated.

2.5 PUMP SPECIALTY FITTINGS

- A. Pump Suction Diffuser: Taco RSP; full length straightening vane assembly ensures uniform flow to the suction inlet of the pump; oversized body cylinder ensures minimal pressure drop; metering port allows for the monitoring of system conditions; disposable fine mesh start-up strainer promotes cleaner, more trouble-free system; removable cover plate and reusable “O” ring allows for easy access and maintenance of permanent strainer; blow down port allows for routine maintenance and removal of sediment and debris; ductile iron body; provide the optional magnetic insert to trap small metallic particles; Class 125 flanges or grooved connections.

- B. Pumps without VFD's shall be fitted with a discharge multi-purpose balancing valve or other means of providing system balance, isolation, and check feature for reverse flow. The valve shall be straight or angle pattern and shall be field convertible between the two. The valve shall be ductile iron and rated for 250 psi working pressure. The valve flanges shall be matched to suit the working pressure of the piping components on the job; with either ANSI class 125 psi flanges or ANSI class 250 flanges. The valve shall include the following components; non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation. Valve shall be serviceable under full system pressure. The valve shall be a Taco model MPV Plus Two multi-purpose valve or equivalent.
- C. Pumps with VFD's shall have a check valve and shutoff valve instead of the multi-purpose valve.
- D. Pumps 5HP and larger: Furnish/Install the Flex-Hose Co.'s Flexzorber NND molded double arch spherical connector/expansion joints at the pump suction and discharge. The molded spherical body shall be manufactured using multiple plies of nylon tire cord fabric bonded within the neoprene elastomer (to avoid exposure to atmosphere or media) and must be reinforced with a spring steel wire. Floating/rotatable flanges shall be zinc-coated plate steel and must have drilled bolt holes in accordance with ANSI 150# standard. Exterior galvanized ductile iron reinforcing ring between sphere arches to maintain double profile. The rated design pressure of the molded body must have a minimum 3:1 safety factor (burst to operating pressure) based on a maximum operating temperature of 220oF, and must also be capable of 26" Hg vacuum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations for compliance with requirements for installation. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps and equipment according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings. If necessary to meet this requirement, provide additional pipe supports and flex connectors.
- D. Pumps shall **NOT** be run dry to check rotation.

3.3 INLINE PUMPS

- A. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles. Install fittings and specialties as detailed on the plans.
- E. Provide a single gage with three-input selector valve; locate at pump suction and discharge tapings, also strainer.
- F. Install electrical connections for power, controls, and devices. Electrical power and control wiring and connections are specified in Electrical Specification Sections. Ground equipment. 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 COMMISSIONING

- A. Verify that pumps are installed and connected according to the Contract Documents.
- B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- C. Perform the following preventive maintenance operations and checks before starting:
 - 1. Lubricate bearings.
 - 2. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 - 3. Verify that pumps are free to rotate by hand. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
 - 4. Check suction piping connections for tightness to avoid drawing air into pumps.
 - 5. Clean strainers.
 - 6. Verify that pump controls are correct for required application.
- D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
 - 1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
 - 2. Open sealing liquid-supply valves if pumps are so fitted.
 - 3. Start motors with suction valves open and discharge valve closed. Open discharge valves slowly.

4. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
 5. Check general mechanical operation of pumps and motors.
 6. Follow manufacturers recommended procedures.
- E. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

- A. The control package manufacturer's factory trained representative shall provide start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the Owner or Owner's designated representative. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
- B. The pump control package manufacturer's factory trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

END OF SECTION 23 21 23

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 8 for Access Doors
 - 2. Division 23 Section "Common Work Results for Mechanical"
 - 3. Division 23 Section "Mechanical Insulation"
 - 4. Division 23 Section "Air Terminals"
 - 5. Division 23 Section "Diffusers, Registers, and Grilles."
 - 6. Division 23 Control Section
 - 7. Division 23 Section "Testing, Adjusting, and Balancing".

1.2 SUMMARY

- A. This Section includes metal ducts and accessories for heating, ventilating, and air-conditioning systems.

1.3 SYSTEM DESCRIPTION

- A. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions, which may be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
- B. The contractor must comply with the enclosed specification in its entirety. If on inspections, the engineer finds changes have been made without prior written approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.
- C. At the discretion of the engineer, sheet metal gauges, and reinforcing may be randomly checked to verify all duct construction is in compliance.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC

Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", ASCE/SEI 7, and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
- D. Ductwork Specialties Product Data; provide for the following:
 - 1. Sealant
 - 2. Duct Liner
 - 3. Duct-mounted access doors and panels.
 - 4. Flexible ducts.
 - 5. Backdraft dampers.

6. Manual-volume dampers: Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval.
7. Fire and smoke dampers: Provide complete submittal information (including installation instructions) and the manufacturer's certification of compliance with these specifications for approval prior to bidding. Contractor shall include damper manufacturer's Installation Instructions as part of the submittal. These instructions shall describe the applicable requirements for damper sleeve thickness, retaining angles, and methods of attachment, duct-to-sleeve connections, preparation of wall or floor openings, and all other requirements to provide an installation equivalent to that tested by the damper manufacturer during the UL Standard 555 qualification procedures. Contractor shall detail any proposed installations that deviate from these manufacturer's instructions and explain the needed deviations.
8. Louvers: Include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals. For units with factory-applied color finishes, provide color chart. Provide product test reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling – examples: lighting fixtures, sprinklers, etc.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.8 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. National Fire Protection Association (NFPA):
 - 1. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
 - 2. 96-2008: Ventilation Control and Fire Protection of Commercial Cooking Operations
- D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 1. 3rd Edition: 2005 HVAC Duct Construction Standards, Metal and Flexible
 - 2. 1st Edition: 1985 HVAC Air Duct Leakage Test Manual

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and fire stopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Deliver, store and handle materials according to manufacturer's written recommendations.
- C. All ductwork, equipment, and fittings delivered and stored on the job site must be capped to prevent the entry of moisture, construction dust or other debris.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 or G90 as indicated.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of un-braced panel area, unless ducts are lined. All large ducts must be braced as required to prevent drumming.
- E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fig. 2-3 Rectangular Elbows: Type RE2 square throat with vanes, Type RE1 radius (1.5W minimum), or Type RE5 dual radius. Square throat is not allowed.
 - 2. Vane support in elbows: Fig 2-4. Turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically. Tab spacing shall be as specified in Figure 2-3 of the 1995 SMACNA Manual, "HVAC Duct Construction Standards, Metal & Flexible" Second Edition standard. Rail systems with non-standard tab spacing shall not be accepted. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer's instructions.
 - 3. Fig. 2-5 Rectangular Divided Flow Branches: Type 1, Type 2, Type 4A, or 4B.
 - 4. Fig. 2-6 Branch Connections: 45-degree entry, 45-degree lead-in, bell-mouth or spin-in (single diffuser supply only).
 - 5. Fig. 2-7 Offsets and Transitions. Use gradual offsets as shown, 90-degree offsets shall be avoided.

2.3 ROUND DUCT FABRICATION

- A. Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" latest edition.
- B. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Exposed Round Ducts: Shall be Spiral Seam (RL-1 seam) at 2-inch wg construction.
 - 2. Concealed Round Ducts: Shall be longitudinal Grooved Seam Flat lock (RL-5 seam) at 2-inch wg construction.
 - 3. Snap lock seams shall not be used for this project.
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Supports For Roof Mounted Items:
 - 1. Equipment rails shall be galvanized steel, minimum 18-gauge, with integral baseplate, continuous welded corner seams, factory installed 2x4 treated wood nailer, 18-gauge galvanized steel counter flashing cap with screws, built-in cant strip; minimum height 11 inches. Provide raised cant strip to start at the upper surface of the insulation.
 - 2. Pipe/duct pedestals: Provide a galvanized unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
 - 3. Provide in accordance with Division 7.

2.5 SEALANT MATERIALS

- A. Joint Sealant/Mastic: Shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air and moisture into the duct system. Sealer shall be UL 723 and UL 181 listed and meet NFPA 90A requirements.
 - 1. Maximum 5 flame spread and 0 smoke-developed (ASTM E-84 Tunnel Test).
 - 2. Generally provide liquid sealant for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger.
 - 3. Resistance to mold, mildew and water: Excellent
 - 4. Color: Gray
 - 5. Duct sealant/mastic shall meet requirement for "LEED IEQ Credit 4.1: Low Emitting Materials: Adhesive and Sealant". ITW TACC Miracle Kingco water-based sealants, or approved equal.
- B. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- C. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 FITTINGS

- A. Tees, Laterals, and Conical Tees: Use 45 degree; fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Diameters 3 through 8 inches shall be two-section die stamped; all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
- D. Low-point drains: Ductmate moisture drain with funnel collection design; 3/4" connection with drain fitting and cap.

2.7 DUCT LINER

- A. Flexible Elastomeric
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Armacell LLC; AP Armaflex, or a comparable product by one of the following:

- a. Aeroflex USA Inc.; Aerocel.
 - b. RBX Corporation; Insul-Sheet 1800
2. Armaflex: All ducts, where shown on the drawings, shall be lined with thick AP/Armaflex SA duct liner, or approved equal. The liner shall meet the requirements of NFPA 90A and UL 181.
- a. Temperature Range: -40F to 180F.
 - b. Thermal conductivity: 0.27 @ 75°F (24°C) mean temp (ASTM C 518).
 - c. Water vapor transmission: less than 0.08 (1.16×10^{-13}) (ASTM E 96, Procedure A)
 - d. Water vapor transmission: less than 0.2% by volume (ASTM C 209)
 - e. Microbial growth: none (ASTM C 1071), ASTM G21- fungal), ASTM G22 – bacterial).
 - f. Erosion Resistance: Does not break away, flake off or show evidence of delamination at velocities of 6,000ft./min. (ASTM C 1071)
 - g. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - h. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A. Duct liner adhesive sealants shall meet requirement for “LEED IEQ Credit 4.1: Low Emitting Materials: Adhesive and Sealant”.
 - i. Comply with ASTM C 534, Type II, Grade 1, for sheet materials.
 - j. Provide product recognized under Underwriters Laboratories "UL 94 - Plastic Component Classification" and listed in Factory Mutual "FM Approval Guide."
- B. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

2.8 LOUVERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ruskin Company
 2. American Warming and Ventilating, Inc.
 3. Arrow United Industries.
 4. Cesco Products.
 5. Construction Specialties, Inc.
 6. Greenheck.
- B. Louvers shall be AMCA Licensed. Louvers shall comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- C. Horizontal, Drainable-Blade Louver:
1. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
 2. Mullion Type: Exposed.
 3. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- D. Fixed, Formed-Metal Acoustical Louver: Louver with formed-metal blades filled on interior with mineral-fiber, rigid-board, acoustical insulation retained by perforated metal sheet of same material and finish as blade.
1. Frame Material: Extruded aluminum or aluminum sheet, not less than 0.080-inch nominal thickness.
 2. Blade Material: Aluminum sheet, not less than 0.08-inch nominal thickness.
 3. Blade Shape: Straight.
 4. Blade Angle: 45 degrees unless otherwise indicated.
 5. Blade Spacing: 6 inches o.c. for 8-inch-deep louvers.
 6. Airborne Sound-Transmission Loss: STC 10 per ASTM E 413, determined by testing according to ASTM E 90.
 7. Outdoor-Indoor, Sound-Transmission Loss: OITC 10 per ASTM E 1332, determined by testing according to ASTM E 966.
- E. Provide aluminum insect screens.
- F. Louver Finishes:
1. 2-coat 70% KYNAR 500®/HYLAR 5000® AAMA 2605 – Dry film thickness 1.2 mil. (AKA: Duranar®, Fluoropon®, Trinar®, Fluoropolymer, Polyvinylidene Fluoride, PVDF2); Tough, long-lasting coating has superior color retention and abrasive properties; Resists chalking, fading, chemical abrasion and weathering.
 2. Color shall match adjacent trim, custom color per Architect.

2.9 MANUAL-VOLUME DAMPERS

- A. Manual balancing dampers meeting the following specifications shall be furnished and installed on all branch ducts and where shown on plans. Testing and ratings to be in accordance with AMCA Standard 500-D.
- B. Single-Blade Rectangular Dampers shall consist of: an 18 ga. galvanized steel frame with 3-1/2 in. depth; blades fabricated from 20 ga. galvanized steel; integral 1/2 in. dia axles. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD-10.
- C. Multi-Blade Rectangular Dampers shall consist of: a 16 ga. galvanized steel hat channel frame with 5 in. depth; triple V type blades fabricated from 16 ga. galvanized steel; 1/2 in. dia. plated steel axles; external (out of the airstream) blade-to-blade linkage. Damper suitable for pressures to 4.0 in. w.g. (996 Pa), velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD15.
- D. Round dampers shall consist of: a 20 ga. galvanized steel frame with 6 in. depth; blades fabricated from 20 ga. galvanized steel; 3/8 in. square plated steel axles turning in acetal bearings. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBDR50.

2.10 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.
 - 2. Cesco Products
 - 3. Greenheck Fan Corporation.
 - 4. METALAIRE, Inc.
 - 5. Nailor Industries Inc.
 - 6. Prefco
 - 7. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555S by an NRTL.
- C. Dynamic dampers: Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Ratings: 1-1/2 hours for 1 and 2 hour walls; 3-hours for 3-hour walls. The hour ratings for fire dampers must be 75% of the hour rating for the wall, floor or partition.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.
- K. Provide the grille option for curtain style fire dampers provides mounting flanges on the sleeve to ease installation of grilles in the field (Grilles specified in Section 23 37 13). The flanges shall be made out of 20 gauge galvanized steel (3/4 inch x 2 in. long) with .149 in. diameter hole for fastening of grille. The flanges are concealed when the grille is installed.

2.11 SMOKE DAMPERS AND FIRE/SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.
 - 2. Cesco Products
 - 3. Greenheck Fan Corporation.
 - 4. METALAIRE, Inc.
 - 5. Nailor Industries Inc.
 - 6. Prefco
 - 7. Ruskin Company.
- B. Greenheck Model: FSD-211 series combination fire smoke dampers.
- C. Ratings:
 - 1. Fire Resistance: Dampers shall have a UL 555 fire resistance rating of 1½ hours.
 - 2. Fire Closure Temperature: 165°F
 - 3. Elevated Operational Temperature: Dampers shall have a UL 555S elevated temperature rating of 350°F.
 - 4. Leakage: Dampers shall have a UL555S leakage rating of Leakage Class I.
 - 5. Differential Pressure: Dampers shall have a minimum UL 555S differential pressure rating of 4 in. wg.
 - 6. Velocity: Dampers shall have a minimum UL 555S velocity rating of 2000 fpm.
 - 7. Dampers shall meet requirements for combination fire smoke dampers in accordance with NFPA 80, 90A, 92A, 92B, and 101.

8. Dampers shall be tested, rated, and labeled in accordance with: UL 555 (Seventh Edition), Listing R13317, UL 555S (Fourth Edition), Listing R13317
9. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.

D. Construction:

1. Frame: Damper frame shall be 16 ga. galvanized steel formed into a 5" x 1" structural hat channel. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 1/2" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.
2. Blades: Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1" deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.
3. Blade Stops: Each blade stop (at top and bottom of damper frame) shall occupy no more than 1/2" of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.
4. Seals:
 - a. Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
 - b. Jamb: Flexible stainless steel compression type.
5. Linkage: Concealed in jamb.
6. Axles: Minimum 1/2 inch dia. plated steel. Frame: Galvanized steel (in gauges required by manufacturer's UL listing).
7. Sleeves: Damper shall be supplied as a single assembly with an integral factory sleeve.
8. Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.
9. Bearings: Axle bearings shall be sintered bronze sleeve type rotating in polished extruded holes in the damper frame.

E. Actuators:

1. Type: Electric, 120V AC, 2-position (open or closed).
2. Fail direction: closed
3. Mounting: External
4. Installed on outside of factory sleeve.
5. Factory Tests: Factory cycle damper and actuator assemblies to assure proper operation.
6. Provide an auxiliary end switch built into the actuator.

F. Provide for all SD or FSD: No-flow UL 268A listed smoke detector rated for systems without a minimum operating velocity. Smoke detector shall be rated for air velocities 0 to 3000 fpm and shall be mounted internally to the damper sleeve.

G. Test switch: Provide a U.L. listed momentary smoke damper test switch for all SD/FSD. The momentary test switch shall enable easy maintenance and inspection of dampers by allowing the dampers to be tested and cycled by one person, right at the damper location by simply

holding the test switch down. This eliminates the need for the help of another person in the control room. One test switch shall be provided per closure device.

- H. Actuators and accessories shall be wired to a single junction box for a convenient single point wiring installation.
- I. Provide an access door in the sleeve or adjacent to the SD/FSD in the ductwork. Access door must be positioned for proper access.

2.12 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. McGill Air Flow LLC.
 - 4. Nailor Industries Inc.
 - 5. Cesco
 - 6. Buckley
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular; rated for up to 4.5" static pressure.
 - b. Door panel filled with 1" fiberglass insulation; ¾ lb. density.
 - c. Hinges and Latches: 1-by-1-inch continuous piano hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs.
 - 3. Provide 1/8" thick neoprene gaskets.
 - 4. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 inches square: No hinges and two cam locks.
 - b. Access Doors up to 24 Inches Square: One hinge and cam locks.
- C. Grease Duct Access Doors: Ductmate Grease Duct Sandwich Access Door or approved equal; two layers of precision stamped, hot-dipped galvanized steel, and one 16 gauge black iron backing plate. Doors shall be tested to -20" W.C. with no leakage noted. The backing plate shall be spot welded to the inside panel. Gasket: Ceramic Fiber Gasket (2300°F max—meets NFPA 96 standards) shall be permanently bonded to the outside panel of the access door to eliminate leakage. Zinc plated conical springs shall be installed between the inner and outer door, to facilitate opening. Provide zinc coated wing nuts for access; zinc plated carriage bolts, welded and sealed to the inner door. Provide a self-adhesive template for the exact size of duct opening required.

2.13 FLEXIBLE CONNECTORS

- A. Provide for all air moving equipment. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 0 or 1. Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts. Duro-Dyne, Hardcast, or approved equal.
- B. Indoor Flexible Connector Fabric: Glass fabric double coated with polychloroprene or neoprene. Minimum Weight: 26 oz. /sq. yd. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.
- C. Outdoor Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber or hypalon, white color; weatherproof coating resistant to the sun's ultraviolet rays and ozone environment. Minimum Weight: 24 oz. /sq. yd. Tensile Strength: 530 lbf/inch in the warp, and 440 lbf/inch in the filling.

2.14 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 0 Or 1. Flame Spread: Less than 25; Smoke Developed: Less than 50.
- B. All products shall be certified by Greenguard Environmental Institute; independent testing of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Greenguard provides independent, third-party certification of IAQ performance. Certification is based upon criteria used by EPA, OSHA and WHO.
- C. Rated Positive Pressure: 10" w.g. per UL-181. Maximum negative pressure: 3/4".
- D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass-fiber insulation around a continuous inner liner.
 - 1. Thickness: 1", R6, Basis of Design: Atco #86
 - 2. Reinforcement: Steel-wire helix encapsulated in inner liner.
 - 3. Outer Jacket: Polyethylene film.
 - 4. Inner Liner: Polyethylene film.
- E. Flexible Ducts, Un-insulated: A triple lamination of metallized polyester, aluminum foil, and polyester shall encapsulate a steel wire helix. Basis of Design: Atco #50
- F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- G. Hangers shall be band type, 1" wide minimum.

2.15 DRYER ACCESSORIES

- A. Provide the following for each dryer.
- B. Roof Cap
 - 1. Terminate the 4" dryer vent with a dryer roof cap with a gravity backdraft damper, no screen.
 - 2. Basis of Design: American Aldes # 22-041.
 - 3. Height: 9"
 - 4. 4" diameter x 3" long stub duct at bottom for duct connection.
 - 5. Footprint of hood is 14" x 14". Provide an 18" x 18" x 18" high roof curb for hood mounting.
- C. Dryer Vent Box
 - 1. Provide an American Aldes Dryer Vent Box; a recessed dryer vent box that allows the dryer to mount flush against the wall.
 - 2. No restrictive bends in the flex duct
 - 3. Saves space and energy
 - 4. Reduces fire hazard
 - 5. Less drying time equals improved dryer efficiency
 - 6. Dryer can be installed against the wall
 - 7. 22-gauge aluminized steel box shall be rigid, rust free, and paintable
- D. Dryer Lint Trap
 - 1. In-O-Vate Model DT4 dryer exhaust secondary lint trap.
 - 2. 5-1/2" depth, fits in 6" studs.
 - 3. White, powder coated door with clear inspection window.
 - 4. SS lint screen, 38 square inches.
 - 5. Recess mount

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts and accessories according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Construct and install each duct system for the specific duct pressure classification indicated.

- D. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.
- E. Install ducts in lengths not less than 12 feet, unless interrupted by fittings. Install ducts with fewest possible joints.
- F. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- G. Install couplings tight to duct wall surface with a minimum of projections into duct.
- H. Install ductwork to allow maximum headroom. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- K. Coordinate layout with suspended ceiling, lighting layouts, and similar finished work.
- L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

3.2 MATERIALS

- A. Hangers, accessories, and dampers shall be same material as parent duct.
- B. All ducts shall be G60 galvanized steel except as follows:
 - 1. Exterior ductwork: Hangers and attachments shall be electro-galvanized, all-thread rod or galvanized rods with threads painted after installation. Refer to SMACNA Fig. 5-3. All ductwork shall be pitched or sloped to prevent "ponding" of water.
 - 2. Exposed Ductwork: Galvaneal (ready for paint)
 - 3. Range Hood Exhaust Ducts: Comply with NFPA 96.
 - a. Concealed: Carbon-steel sheet; 16-gauge minimum thickness.
 - b. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
 - c. Weld and flange seams, joints, and penetrations.
 - 4. Clothes dryer exhaust: galvanized steel.

3.3 DUCT CLASSIFICATIONS AND SEALING

- A. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:
1. Supply Ducts: 2-inch wg.
 2. Return Ducts: 2-inch wg, negative pressure.
 3. Exhaust Ducts: 2-inch wg, negative pressure.
 4. Rooftop ERU's and RTU's: The first 20 feet of ductwork (supply and return) shall have duct liner and shall be fabricated and installed in a stiff and rigid manner, with cross bracing for minimal "drumming"; minimum 6-inch wg. pressure class.
- B. Seam And Joint Sealing
1. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 2. Seal to SMACNA Class A; all joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, or duct sealant. Exceptions:
 - a. Continuously welded and locking-type longitudinal joints and seams on ducts operating at less than 2 in. wg pressure classification.
 - b. Exposed exhaust or return ducts operating at less than 2 in. wg pressure classification.
 - c. Exposed supply ducts in the space that the duct serves.
 3. Seal externally insulated ducts before insulation installation.

3.4 DUCT PENETRATIONS

- A. Fire or Smoke Rated Penetrations not requiring a fire and/or smoke damper: Where ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and fire dampers are not required, the opening in the construction around the duct shall be as follows:
1. Not exceeding a 1" average clearance on all sides.
 2. Filled solid with firestopping material as specified in Section 23 05 00.
- B. Fire-Rated Penetrations – Fire Damper: Provide fire damper as specified under Duct Accessories paragraph.
- C. Smoke-Rated Penetrations – Smoke Damper: Provide smoke damper as specified under Duct Accessories paragraph.
- D. Non-Fire-Rated Exposed Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
- E. Non-Fire-Rated Concealed Penetrations: Provide insulation infill and acoustical sealant around gaps. Tightly seal to prevent sound transmission. Neatly finish.

- F. Mechanical room floor penetrations: Provide 4-inch high concrete curbs or other sealing method to prevent leakage from mechanical room into floor penetration.
- G. Roof penetrations by ducts shall use counter-flashed curbs.
- H. Flexible air ducts or connectors shall not pass through any wall, floor, or ceiling.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension,

3.6 FLEXIBLE DUCT

- A. Provide in accordance with manufacturer's and Air Diffusion Council recommendations.
- B. Flexible ducts shall be supported at manufacturer's recommended intervals, but at no greater distance than 5 feet. Maximum permissible sag is 1/2" per foot of spacing between supports.
- C. Install duct fully extended; do not install in the compressed state or use excess lengths.
- D. Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes, conduits, or hot equipment. Radius at centerline shall not be less than one duct diameter.
- E. Hanger or saddle material in contact with the duct shall be at least 1-1/2" wide.
- F. Provide at least 2 duct diameters of straight duct at the entrance to register, grilles, and diffusers.

3.7 SPECIALTY DUCTWORK

A. Range Hood Exhaust Duct Installations

1. Hood furnished by food service supplier. Division 23 shall install the hood.
2. Kitchen grease hood exhaust ducts: Comply with NFPA 96 and International Mechanical Code-2009.
3. Install ducts to allow for thermal expansion of ductwork through 2000°F temperature range.
4. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
5. Install ducts without dips or traps that may collect residues, unless traps have continuous or automatic residue removal.
6. Install welded test ports in the sides of the exhaust duct for the duct Pitot tube traverse. Install each test port with a threaded cap that is liquid tight. Provide in each straight run at the direction of the TAB contractor.
7. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.
8. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.
9. Grease duct test: Prior to the use or concealment of any portion of the grease duct system (installed in shafts or covered by coatings or wraps that prevent the ductwork from being visually inspected on all sides), a leakage test shall be performed in the presence of the code official. Provide the necessary equipment. A light test or equivalent approved test method shall be performed to determine that all welded joints are liquid-tight. A light test shall be performed by passing a minimum 100-watt lamp through the entire section of ductwork to be tested. The lamp shall be open so as to permit light equally in all directions perpendicular to the duct walls. A test shall be performed for the entire duct system including the hood-to-duct and duct-to-fan connections. The ductwork shall be permitted to be tested in sections, provided that every joint is tested.

B. Clothes Dryer Exhaust

1. Clothes dryers shall be exhausted in accordance with the manufacturer's instructions.
2. Ducts shall not be connected or installed with sheet metal screws or other fasteners that will obstruct the exhaust flow. Provide, clamped, riveted, or welded construction, sealed 100% air-tight.
3. Provide a 4" clamp at connection to dryer and vent hood.
4. Avoid 90-degree elbows, use 45-degree elbows.
5. The male end of the duct at overlapped duct joints shall extend in the direction of airflow.
6. Each vertical riser shall be provided with a means for cleanout.
7. Terminate ductwork at building exterior with a dryer roof cap with back-draft damper. Screens shall not be installed at the duct termination.

3.8 DUCT ACCESSORIES INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible".

- B. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards
- C. Each register, grille, or diffuser shall have a means of air flow adjustment. Provide volume damper in branch duct if not furnished with the RGD.
- D. Adjust operable devices for proper action.
- E. Perform the following as directed by the controls contractor:
 - 1. Installation of:
 - a. Automatic control dampers.
 - b. Smoke control dampers.
 - c. Smoke detectors.
 - d. Necessary blank off plates.
 - 2. Access doors where indicated and as required.
- F. Install duct access panels for access components that require servicing.
 - 1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining per equipment manufacturers' requirements.
 - 2. Install access panels on side of duct where adequate clearance is available.
 - 3. Locate panel upstream and/or downstream as recommended by manufacturer.
 - 4. Locations:
 - a. At outdoor-air intakes and mixed-air plenums.
 - b. 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.

Control devices requiring inspection.

- c. Elsewhere as indicated or required by duct accessory manufacturer
 - d. As required by NFPA 96.
 - e. As shown on the drawings.
- 5. Inspect locations of access doors and verify that purpose of access door can be performed.
- G. Control Damper Installation
 - 1. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
 - 2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure $\frac{1}{4}$ in. larger than damper dimensions and shall be square, straight, and level.

3. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 1/8 in. of each other.
4. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
5. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
6. Provide a visible and accessible indication of damper position on the drive shaft end.
7. Support ductwork in area of damper when required to prevent sagging due to damper weight.
8. After installation of low-leakage dampers with seals, caulk between frame and duct opening to prevent leakage around perimeter of damper.

H. Fire Damper Installation

1. Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected
2. Install dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.
3. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.
4. Install dampers square and free from racking.
5. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.
6. Do not compress or stretch the damper frame into the duct or opening.
7. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.
8. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.
9. Tests and Inspections: Operate dampers to verify full range of movement and verify that proper heat-response device is installed.

- I. Smoke Damper Installation: The contractor shall coordinate all smoke and smoke/fire damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.

3.9 LOUVER INSTALLATION

- A. Louvers to be furnished by Division 23; mounted and installed by the contractor responsible for the outside wall construction. Ductwork shall be connected to the louvers by Division 23.

- B. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings. For new construction, or where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.
- C. Installation
 - 1. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
 - 2. Pitch horizontal ducts and plenums connected to louvers downward toward louvers not less than 1 inch in 10 feet. Connect to louver to allow drainage to exterior. Seal duct water-tight.
 - 3. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
 - 4. Form closely fitted joints with exposed connections accurately located and secured.
 - 5. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
 - 6. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore 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.
 - 7. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather tight louver joints are required.
- D. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- E. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

3.10 DUCT LINER INSTALLATIONS

- A. All portions of duct designated to receive duct liner shall be completely covered with duct liner. All joints shall be neatly butted and there shall be no interruptions or gaps. Duct liner shall be installed with the printed air stream surface treatment exposed to the air stream.
- B. Duct liner shall be adhered to the sheet metal with 90% (minimum) coverage of adhesive complying with the requirements of ASTM C 916.
- C. All transverse edges that are not to receive sheet metal nosing shall be coated. Longitudinal joints shall occur at the corners of ducts. If duct size and standard duct liner product dimensions make exposed longitudinal joints necessary, such joints shall be coated with adhesive designated for duct liner application and which meets the requirements of ASTM C 916. Such

joints shall be additionally secured with mechanical fasteners in accordance with NAIMA FGDLS, or SMACNA HVAC DCS as if they were transverse joints.

- D. Duct liner shall be additionally secured with mechanical fasteners complying with the requirements NAIMA FGDLS or SMACNA HVAC DCS and of the correct type for the duct liner being installed. Fasteners may be either weld-secured or impact-driven, and shall be installed perpendicular to the duct surface. Mechanical fasteners shall not compress the insulation more than 1/8" based on nominal insulation thickness. Fastener spacing with respect to interior duct dimensions shall be in accordance with NAIMA FGDLS or SMACNA HVAC DCS. Fastener heads or washers shall have a minimum area of 0.75 in², with beveled or cupped edges to prevent their cutting into the duct liner.
- E. Where air velocities exceed 4000 fpm, metal nosing (either channel or "zee" profile) shall be installed on upstream edges of liner duct sections.
- F. Metal nosing shall be securely installed over transverse liner edges facing the airstream at fan discharge and at any point where lined duct is preceded by unlined duct.
- G. Duct liner in roll form shall be folded and compressed in the corners of rectangular duct sections, or shall be cut and fit to assure a lapped, compressed corner joint.
- H. Duct liner in sheet form shall be cut and fit to assure tight, over-lapped corner joints. Top pieces of liner shall be supported at the edges by the side pieces.
- I. Any damage to the air stream surface must be repaired by coating the damaged area with adhesive or coating designed for duct liner application. Adhesive or coating shall meet requirements of ASTM C916.

3.11 FIELD QUALITY CONTROL

- A. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- B. HVAC systems shall not be operated during construction.
- C. Upon completion of installation duct systems and before HVAC system start-up, visually inspect the ductwork proper installation
- D. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork. Turn the HVAC system on and allow it to run until steady state operation is reached. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.
- E. All ductwork shall be provided with temporary enclosures to keep the HVAC system free of dust and construction debris. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire duct from the points where the air enters the system to the points where the air is discharged from the system.

- F. Check all filters in accordance with their manufacturer's instructions. Use specified grade of filters at all times that system is operating.

END OF SECTION 23 31 13

SECTION 23 34 23 - POWER AND GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

- A. This Section includes fans and ventilators.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gages and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 7. Vibration Isolation

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal for sound and air performance.
 - 1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
 - 2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standards: Power ventilators shall comply with UL 705.
- E. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Refer to Division 23 Section "Common Work Results for Mechanical"
- B. Coordinate installation wall openings.
- C. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cook
 2. New York Blower Company
 3. Penn Ventilation Companies, Inc.
 4. Acme Engineering & Mfg. Corp.
 5. Greenheck Fan Corp.
 6. Hartzell Fan, Inc.

2.2 DIRECT DRIVE SIDEWALL MOUNTED CENTRIFUGAL KITCHEN EXHAUST FANS

- A. Fan shall be UL listed for kitchen exhaust.
- B. Wheel:
1. Material type: aluminum
 2. Non-overloading, backward inclined centrifugal
 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- C. Motor
1. Motor enclosures: Open type
 2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
 3. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
 4. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor.
 5. Motor shall be a minimum of 85% efficient at all speeds.
 6. Provide Shaft Grounding.
- D. Housing:
1. Constructed of heavy gauge aluminum includes exterior housing, windband, and motor compartment housing. Galvanized material is not acceptable
 2. Housing shall have a rigid internal support structure
 3. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing
 4. Windband to include an integral rolled bead for strength
 5. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it.
 6. Leak resistant

7. Continuously welded seam
 8. Steel mounting plate and integral venturi shall be attached to windband
 9. Motor Cover: Constructed of aluminum
- E. Vibration Isolation: Sized to match the weight of each fan
- F. Disconnect Switches:
1. NEMA rated: 3R
 2. Positive electrical shut-off
 3. Wired from fan motor to junction box installed within motor compartment
- G. Drain Trough: Allows for one-point drainage of water, grease, and other residues
- H. Options/Accessories:
1. Provide options as required to bring the fan into NFPA-96 compliance.
 2. Heat Baffle: 1 inch thick insulation shield that prevents heat from radiating into the motor compartment
 3. Pressure Probe: ¼ inch diameter in the fan venturi that allows hook-up to manometer.
 4. Non-stick wheel

2.3 DIRECT DRIVE SIDEWALL MOUNTED PROPELLER FANS

- A. Wheel:
1. Propeller shall be aluminum blade riveted to steel hub
 2. A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft
 3. Statically and dynamically balanced in accordance with AMCA Standard 204-05
 4. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- B. Motors:
1. ECM Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor.
 2. Accessible for maintenance
 3. Drive frame assemblies and fan panels shall be galvanized steel
 4. Drive frame shall have welded wire or formed channels and fan panels shall have prepunched mounting holes, formed flanges and a deep formed one piece inlet venturi
- C. Disconnect Switches:
1. NEMA rated: 1
 2. Positive electrical shut-off
 3. Wired from fan motor to junction box

D. Options/Accessories:

1. Dampers:
 - a. Type: Gravity or Motorized as scheduled.
 - b. Balanced for minimal resistance to flow
 - c. Galvanized frames with prepunched mounting holes
2. Provide shaft grounding.
3. Mounting: fan discharge attaches to ductwork.
 - a. Fan with fire damper at discharge: Provide 24" minimum straight duct between fan and fire damper.
4. Motor Side Guard:
 - a. Guard type: OSHA Guard
 - b. Protective guard completely enclose the motor and drive side of the fan

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Provide vibration isolation as specified.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in the Division 23 HVAC Identification Section.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Ductwork."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Equipment Startup Checks and Adjustments:
 1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices. Verify that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Inspect and tighten fasteners and setscrews, particularly fan mounting and bearing fasteners.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Verify lubrication for bearings and other moving parts.
7. Lubricate bearings.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Refer to Division 23 Section "Testing, Adjusting, and balancing" for testing, adjusting, and balancing procedures.

F. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.
 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."
 3. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 23 34 23

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC"
 - 2. Division 23 Section "Ductwork"
 - 3. Division 23 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers, and grilles.

1.2 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.3 DEFINITIONS

- A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.
- C. Register: A combination grille and damper.

1.4 SUBMITTALS

- A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Owner's representative of problems prior to shop drawing submittal.
- B. Pressure drop, airflow and noise criteria selection is based on design equipment. Manufacturers not submitting design makes must provide written certification in front of submittal that equipment submitted has been checked against and performs equal to the design make.
- C. Product Data: For each model indicated, include the following:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.

2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
- D. Coordinate locations with reflected ceiling plans and wall elevations as applicable.
- E. Coordinate mounting frame with associated mounting surface.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."
- C. Sound pressure levels shall be determined by using AHRI Standard 885-2008 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Outlets".

PART 2 - PRODUCTS

2.1 GENERAL

- A. Diffusers, registers, and grilles are scheduled on Drawings.
- B. Mounting type shall match the mounting surface. Coordinate with mounting conditions.
- C. Material shall match the specified ductwork. Coordinate with Section 23 31 13 "Ductwork".
- D. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- E. Grilles shall be finished in White Powder Coat, unless noted otherwise.
- F. Manufacturers
1. Price
 2. Titus
 3. Metal-Aire
 4. Anemostat
 5. Nailor

2.2 RETURN OR EXHAUST

A. Return/Exhaust Grille, 45-degree deflection

1. Material: aluminum (Price 630 Series)
2. Grilles of the sizes indicated on the plans. Grilles shall be 45 degree deflection fixed louver type with blades spaced 3/4" on center. The blades shall run parallel to the long dimension of the grille.

B. Filter Exhaust Grille, 45-degree deflection

1. Material: aluminum (Price 630FF Series)
2. Provide damper as scheduled.
3. Grilles of the sizes indicated on the plans. Grilles shall be 45 degree deflection fixed louver type with blades spaced 3/4" on center. The blades shall run parallel to the long dimension of the grille.
4. The border shall be mounted to the filter frame with 1/4 turn quick-release fasteners.
5. The mounting frame shall accept a standard 1" MERV 6 media. Provide filter.

2.3 SUPPLY

A. Double-deflection Supply Register

1. Material: aluminum (Price 620D Series)
2. Grilles of the sizes indicated on the plans.
3. Registers shall be double deflection type with two sets of fully adjustable deflection blades spaced 3/4" on center. The front set of blades shall run parallel to the short dimension of the register.
4. The integral volume control damper shall be of the opposed blade type. Material shall match the register material. The damper shall be operable from the register face.

B. High-induction Ceiling Diffusers

1. Material: steel (Price Model SMX)
2. Air pattern shall be 1-way, 2-way, 3-way, or 4-way as scheduled.
3. Rapid mixing diffusers shall consist of an outer frame assembly which facilitates mounting. A collar that allows connection to the square (or rectangular) duct size indicated shall be an integral part of the frame assembly. This collar shall fit inside the duct.
4. Internally mounted discharge vanes shall be engineered to create a high rate of induction that will rapidly mix warm room air with the conditioned supply air. This rapid mixing (induction) shall quickly equalize the temperature differential between the two air masses, thus minimizing the chances of uncomfortable drafts.
5. Provide a square to round adaptor shall be of coated steel construction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- B. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connection to ducts.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.
- B. Adjustable outlet diffuser: adjust pattern for draft-free air distribution.

3.4 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 23 37 13

SECTION 23 51 00 – CHIMNEYS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC"
 - 2. Division 23 Section "Condensing Boilers"

1.2 SUMMARY

- A. This Section includes the following: Chimneys, vents, and connectors.

1.3 SUBMITTALS

- A. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
- B. Factory Developed Drawings: Provide factory drawings which show specific chimney system layout complete with dimensions, penetrations, attachments and complete parts identification list.
- C. Provide factory draft calculations of specific chimney system for engineer's review.
- D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. All work shall be in accordance with Maine Fuel Board Rules.
- B. All work shall be in accordance with NFPA 211, Chimneys, Fireplaces, Vents, and Solid Fuel Appliances, 2006 edition.
- C. All work shall be in accordance with UL1738 "Venting systems for gas-burning appliances, Categories II, III, IV"
- D. Source Limitations: Obtain listed system components through one source from a single manufacturer.
- E. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 COORDINATION

- A. Coordinate installation of roof penetrations with Division 7.

1.6 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
- B. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENT

- A. Available Manufacturers:
 - 1. AMPCO
 - 2. Heat-Fab Inc.
 - 3. Industrial Chimney Company.
 - 4. M&G / Duravent
 - 5. Metal-Fab, Inc.
 - 6. Schebler Co. (The).
 - 7. Selkirk
 - 8. Van-Packer Co.
 - 9. Security Chimneys
- B. Venting material, layout, and fittings shall be approved by the submitted boiler manufacturer.
- C. The factory-built Special Gas Vent system shall be factory prefabricated, and shall be tested and listed by the Underwriter's Laboratory, Inc., for use with listed natural gas or propane burning equipment that produce continuous flue-gas temperatures not above 550° F.
 - 1. The product shall consist of a flue-gas conduit fabricated from AL 29-4C® stainless steel.
 - 2. The outer jacket shall be constructed of Type 430 stainless steel with a void of approximately 1" between the flue-gas conduit and the jacket.
 - 3. There shall be 1" of air space between the inner and outer walls for insulation.
 - 4. All joints shall be fastened with the patented Ring-and-Tab tapered closure system and are to be sealed with factory approved sealant when used with positive pressure or condensing applications.
- D. The system shall be installed with continuous vertical runs not in excess of 60 feet.
- E. The system can be fully enclosed by combustible materials at 4" or greater clearance from the appliance flue collar to the termination when connected to gas-burning appliances with a maximum continuous flue-gas temperature rating of 400° F, 3"– 6" diameter. All installations of

larger sizes or for temperatures up to 550° F may be installed adjacent to combustible materials on three sides only at 4" clearance or may be fully enclosed by a non-combustible enclosure.

- F. The system is to be sized in accordance with appliance manufacturers' specifications, NFPA54 National Gas Code ANSIZ223.1 and ASHRAE recommendations.
- G. The system shall comply with National Safety Standards and all building codes when installed in accordance with manufacturer's installation instructions.
- H. Accessories: Tees, elbows, increasers, terminations, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
- I. Combustion air intake, flex hose and adaptor shall be provided.
- J. Provide adjustable roof flashings, storm collars, and support assemblies that are compatible with the roofing material specified in Division 7.
- K. Termination: Listed and labeled cap in accordance with vent manufacturer's installation instructions.

PART 3 - EXECUTION

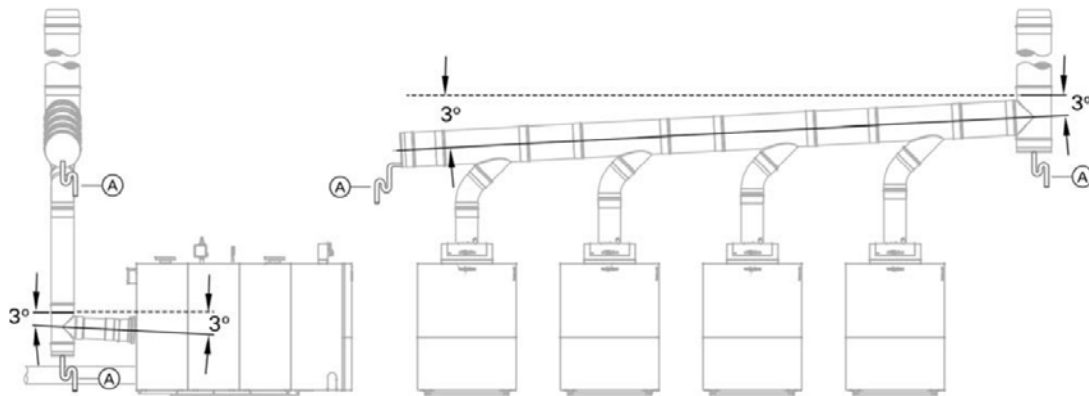
3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Provide in accordance with manufacturers' recommendations.
- B. The venting system must be installed by a licensed professional heating contractor familiar with the operation and maintenance of heating appliances and venting. Before installing, ensure that the complete installation literature has been read.
- C. It is the responsibility of the installer to contact local building and fire officials concerning any installation restrictions and/or inspection requirements that may apply. Permits shall be obtained before commencement of the installation
- D. Provide in accordance with boiler manufacturers requirements, coordinate with Section 235216.
- E. Route vent pipe as directly as possible and with as few bends as possible to the boiler.
 - 1. Do not to use back-to-back 90° elbows.
 - 2. Use 45° elbows (not 90° elbows) in case redirection of flue gas is required.

- F. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- G. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer. The system shall be installed and sealed per manufacturers' instructions so all joints are gas tight, preventing leakage of products of combustion into a building.
- H. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading. Support vents and chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps according to manufacturer's written instructions.
- I. Slope vents and connectors in accordance with NFPA 211. Condensate must drain from the flue pipe to the boiler. Ensure a suitable gradient of at least 3° [approx. 2 in. per 3.3 ft.]. Provide low point drains, trapped and piped to floor.



Legend

- Ⓐ Condensate drain piping
- a air intake
- b exhaust vent

IMPORTANT

Condensate must drain from the flue pipe to the boiler. Ensure a suitable gradient of at least 3° [approx. 2 in. per 3.3 ft. (50 mm per 1 m)] on any horizontal venting components.

- J. Provide flue vent dampers per boiler manufacturer's recommendations.
- K. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.
- L. Install, support, and restrain according to seismic requirements.
- M. Termination height of chimneys shall be in accordance with NFPA-211.

3.3 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

- B. Clean vents internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of vents and chimneys that are not completed or connected to equipment.

END OF SECTION 23 51 00

SECTION 23 52 16 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes packaged, factory-fabricated and assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION 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.
- C. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. Heat Exchanger Damaged by Thermal Shock: 10 years from date of Substantial Completion.
 - b. Heat-Exchanger Corrosion: Non-prorated for ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Viessmann
 - 2. Buderus
 - 3. Cleaver Brooks
- B. General
 - 1. The gas-fired hot water condensing heating boiler shall be fabricated of high grade stainless steel (SA240-316Ti). The heat exchanger shall utilize the heating surface for maximum heat transfer and condensation for optimum energy savings. The smooth, non-fin heat exchanger surfaces shall provide a self-cleaning effect while promoting clean combustion through low heat exchanger loading and a straight-through design.
 - 2. The boiler shall incorporate a modulating compact pre-mix cylindrical stainless steel gas burner with a high-alloy stainless steel surface capable of operating with consistently high efficiency. The burner shall be equipped with a variable speed combustion fan for quiet and economical operation.
 - 3. Boiler turn-down ratio shall be 5:1.

4. Combustion efficiency shall not be below 95% and thermal efficiency shall not be below 97% as tested to AHRI, BTS-2000 Testing Standard Method to Determine Efficiency of Commercial Heating Boilers.
5. ASME maximum allowable working pressure (MAWP): 75 psig. Provide a 55 PSIG pressure relief valve.
6. ASME maximum water temperature (Fixed High Limit): 210°F.
7. Maximum boiler operating temperature (Adjustable High Limit): 190°F.
8. The boiler shall operate without a flow switch. No additional safety devices shall be required to safeguard against low flow conditions.
9. The boiler shall be capable of accommodating a 50% glycol mixture.
10. The boiler shall have low flow resistance. At the maximum flow rate through the heat exchanger, the boiler shall have head resistance not greater than 14 inches of water column.
11. The condensation rate, controlled by optimum combustion, shall be able to meet a CO₂ value of 10% through the entire firing range.
12. The standard control options shall be able to operate independently, or integrate with building management system protocols as referenced in the control section.

C. Construction

1. The combustion chamber, heat exchanger and condensate collector shall be constructed of high-alloy stainless steel and titanium.
2. The R-value of the insulation shall be equivalent to 4" mineral wool with nylon backing.
3. The flue gasses shall pass by the return water in a counter-flow direction only, for maximum heat transfer effectiveness.
4. The heat exchanger shall be of a compact design for ease of handling, and incorporate a full-swing door, left- or right-hinge, to allow for easy inspection and cleaning.
5. The burner shall be constructed from high-grade stainless steel for universal use with natural gas or propane gas. Burner ignition shall be by a direct spark ignition system.
6. The burner shall be capable of operating at natural gas pressures from 4 up to 14" W.C., and propane gas pressure of 10 up to 14" W.C.

D. Certifications

1. Individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component. Boiler shall be CSA approved and shall be built in compliance with ASME Section IV, carrying the "H" stamp.
2. The boiler shall have the following approvals and listings, or be in compliance with: CSA, CRN, ASME, and AHRI.

E. Control Specifications: Vitotronic 300, GW6B

1. General

- a. The Vitotronic 300 GW6B shall be capable of operating as a standalone boiler control with outdoor reset capabilities or shall be cascadable as part of a multi boiler system (to a maximum of 8 boilers using the Viessmann LON protocol) for boiler set point operation.
- b. In standalone operation the control unit shall provide control for a boiler with one high temperature circuit and one mixing valve circuit with the integrated mixing

valve module, using digital weather responsive reset. Additional circuits shall be added with the order of an ancillary mixing valve controller and/or a custom control panel. System components shall use the Viessmann LON communication protocol. The outdoor reset supply temperature of every heating circuit shall result from the outside temperature, the set room temperature, the operating mode and the heating curve.

- c. In cascade operation each boiler shall be supplied with an integrated LON card for communication between boilers, via the Viessmann LON Protocol. In cascaded operation one boiler will be selected and programmed as the 'Master Boiler' with the remaining boilers being programmed as 'Slave Boilers'. The boilers shall be operated on a set point temperature only generated through the 'Master Boiler' and delivered to the cascade system via the Viessmann LON protocol. The 'master' control unit shall provide control for a heating system with one high temperature circuit and two mixing valve circuits with the integrated mixing valve module, using digital weather responsive reset. Additional circuits shall be added with the order of an ancillary mixing valve controller and/or a custom control panel.
- d. The controller shall have the following features:
 - 1) 5 Inch color touch screen user interface.
 - 2) Compatible with Viessmann modulating burner.
 - 3) EPROM memory is maintained without main power.
 - 4) Control algorithms are PID-based.
 - 5) LON ready with integrated Viessmann LON communication module.
 - 6) Quick connect plug & play system for low voltage controls.
 - 7) Communication with other protocols such as Modbus, BacNet and LON (Ethernet/IP) shall be available (through accessories gateways).
- e. The controller shall be factory tested and approved by CSA as part of a package with the compatible series of boilers.
- f. The controller (in standalone or master boiler operation) shall be able to support the following output devices. Provide wiring from controller to output devices.
 - 1) (1) Viessmann Modulating burner.
 - 2) (1) Modulating boiler isolation valve.
 - 3) (1) Boiler Pump.
 - 4) (1) Domestic hot water pump.
 - 5) (1) Domestic hot water re-circulation pump.
 - 6) (2) Low Temperature heating loop circulation pumps in conjunction with mixing valves.
 - 7) Heating loop modulating mixing valve.

2. Construction

- a. Control Interface: The control interface shall be a digital display capable of displaying temperatures as °C or °F, with menu driven selection functions, with access to the following operating points:
 - 1) Able to display all system temperatures and set points.
 - 2) Displays unique fault message during an alarm.
 - 3) A program selection mode.
 - 4) Domestic hot water temperature set point adjustment.

- 5) Information indicator with confirmation.
- 6) Boiler operating hours display.
- 7) Number of burner starts display.
- 8) Operating status check.
- 9) Emission/service test switch (TUV).
- 10) Adjust the display contrast.
- 11) Temporary occupied mode function.
- 12) Slope and shift adjustment for heating curve.

b. The controller shall have the following additional features:

- 1) On/Off switch.
- 2) Default factory settings reset.
- 3) Operating status indication light.
- 4) Tamper-proof fixed high limit (integrated in burner control).
- 5) TUV service switch (overrides electronic high limit).
- 6) Fault Indicator light.
- 7) Operating condition scans.
- 8) Maintenance requirement status.
- 9) Relay test function.
- 10) Integrated boiler flue gas temperature sensor.
- 11) Participant check (LON nodes).
- 12) Quick heat up and quick set-back functions.
- 13) Start-up and shut-down optimization functions.
- 14) Warm weather shut-down.
- 15) Energy savings mode.
- 16) Ability to restore the control to factory defaults.

c. The fixed high limit shall have the following tamper-proof features: CSA certified burner control with integrated Electronic Fixed and Adjustable High limit sensors are used.

3. Boiler System Supply Water Temperature Control

- a. Each controlled zone shall have a calculated heating curve which describes the required supply water temperature at different outside air temperatures. The slope and shift of each heating curve shall be adjusted to fit any type of building or system.
- b. In the unoccupied mode, the supply water temperature set-point shall be reduced by a pre-determined amount. A call for domestic hot water or an external demand signal shall override this set-point to pre-determined values.
- c. Control logic shall be equipped to protect the heating system from freeze-up if left powered during the off season.

4. Domestic Hot Water Control

- a. The DHW temperature shall be controlled through starting and stopping the DHW circulation pump. An automatic or individual time program shall be selected for the control of the DHW and the DHW tank re-circulating pump. An individual time program shall enable up to four switching periods per day to be set to control the DHW heating and the DHW re-circulation pump.

- b. The DHW control sequence shall use an adaptive algorithm that takes into account the rate at which the temperature changes and whether the boiler will be required to supply heat after the DHW tank has been heated or whether residual boiler heat should be transferred to the DHW tank. Available domestic hot water strategies shall include: priority control (supply water set-point increases, the mixing valve closes and the heating circuit pumps are shut off on a call for DHW), modulating priority (the supply water set-point of the mixing valve circuits shall be reduced until the DHW supply temperature requirements have been met), or no priority at all.
 - c. A frost protection function shall energize the DHW production should the supply water temperature drop below a pre-determined value. An optional second temperature sensor placed in the cold water inlet can be incorporated to determine if DHW production should begin prematurely.
5. If a fault occurs on a boiler, the fault code shall be indicated in the display window and by the flashing red fault lamp. A compiled failure alarm contact shall close in order to signal the alarm condition to a Building Automation System (BAS). The message shall also be broadcasted on the LON communication bus. The error history shall be saved to memory.
6. Scheduling: There shall be separate time schedules for central heating, DHW heating and the DHW re-circulation pump. Each device shall be able to be scheduled to switch between occupied and unoccupied modes up to four times per day.
7. Boiler Rotation (Master Boiler): The boilers shall be rotated once a month according to an equal run-time strategy or on a schedule every 200 to 2000 hours. A dry contact shall be incorporated to make the current lead boiler the lag boiler whenever contact is closed. If the system has both condensing and non-condensing boilers, the condensing boiler shall be programmed to always be the lead.
8. Provide temperatures sensors for boiler plant control as required.
9. Auxiliary Inputs - The following dry contact inputs shall be available to be wired to each boiler to control the following functions (functionality dependent on operating mode):
 - a. Boiler disable.
 - b. Change between modulating to staged burner control.
 - c. External heat demand.
 - d. Boiler sequencing.
 - e. External enable.
 - f. External blocking.
 - g. Heating program changeover.
10. Building Management System Interface
 - a. The controller shall have the ability, through the use of an Extension Module, to accept a 0-10V signal from a Building Management System for the purpose of allowing remote control of the boiler supply water temperature set point.
 - b. The controller shall be able to fully integrate with Building Management Systems running on the BACNet, Modbus, or LON (Ethernet/IP) communication protocols via a gateway.

11. Remote Communication Interface

- a. The controller shall have the ability to be connected to a phone dialer, enabling remote control of any of the functions listed in the Auxiliary inputs section.
- b. The controller shall have the ability to be connected to an Internet server interface, which shall allow access to all programming and operating parameters over the World Wide Web (when used in conjunction with BMS interface and accessory communication gateway).

12. Certifications

- a. All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component.
- b. All electrical wiring is to be done in accordance with the latest editions of: CSA C22.1 Canadian Electrical Code and/or local electrical codes (for Canada) ANSI/NFPA 70 National Electrical Code (for U.S.)

F. Venting

1. Boilers shall be installed and vented with a common flue and individual direct piped combustion air.
2. Vent: Provide per 235100.
3. Combustion Air: The air inlet pipe shall be CPVC pipe. The air inlet shall with a listed cap. CPVC shall comply with ASTM F441 pipe and fittings; ASTM F493 cement/primer.

G. Provide Options:

1. Combustion air vent kit including hoses, burner inlet adaptor, retaining clamps, and hardware.
2. Flue gas vent coupling.
3. Flue vent damper and controls.
4. Condensate Neutralization Kit complete with neutralizing granulate; ¾" inlet/outlet.
5. Low Water Cutoff w/Manual Reset & Test
6. The Firing Control System shall meet CSD-1 and FM requirements.
7. Valve adapters for the interface between the boiler controller and the mixing valve and isolation valves.
8. Provide heating loop mixing valve.
9. Provide boiler isolation valve.

2.2 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
- B. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- C. Examine mechanical spaces for suitable conditions where boilers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting: Install floor-mount boilers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 23 05 00.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.

3.3 BOILER PLANT WIRING

- A. Gas-fired boilers shall be wired in accordance with NFPA 54 requirements.
- B. Wire the boiler plant controls in accordance with manufacturer's recommendations. Coordinate work with Section 23 09 93.
- C. Install electrical devices furnished with boiler but not specified to be factory mounted.
- D. Install control wiring to field-mounted electrical devices.
- E. A flow switch is used to guarantee flow through the boiler before allowing it to fire. The flow switch shall be installed at the boiler outlet.
- F. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Provide pressure regulator to provide proper gas pressure to boilers. Provide 18" minimum straight piping at inlet and outlet of pressure regulator.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.

3.5 INSTALLATION OF VENTS

- A. Provide in accordance with manufacturers' recommendations and Section 23 51 00.
- B. All joints must be sealed. Provide cementing as per CPVC manufacturer's and boiler manufacturer's recommendations.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes. Clean vents internally, during and after installation, to remove dust and debris
- E. Provide temporary closures at ends of vents and chimneys that are not completed or connected to equipment.

3.6 NEUTRALIZATION SYSTEM

- A. Remove the neutralization system cover.
- B. Fill the relevant area provided with neutralizing granulate.
- C. Fill the neutralization system with water
- D. Check the container and the supply and drain lines for leaks.
- E. Connect 1/2" PVC drain piping to the boiler, rout to the neutralizer kit. Install the 1/2 inch PVC tee assembly (shipped with the unit). Leave the top of the 1/2 inch tee open. This is needed as a vacuum break. Pipe to the nearest floor drain.

3.7 FIELD QUALITY CONTROL

- A. Thoroughly flush the system (without boiler connected) to remove sediment.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Prepare test and inspection reports.
- G. 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.
- H. Performance Tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.
 - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 - 7. Notify Architect in advance of test dates.
 - 8. Document test results in a report and submit to Architect.

3.8 DEMONSTRATION

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

END OF SECTION 23 52 16

SECTION 23 72 00 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes packaged energy recovery units.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, furnished specialties, and accessories.
 - 1. Complete fan performance curves for Supply and Exhaust Air, with system operating conditions indicated, as tested on an AMCA Certified Chamber.
 - 2. Sound performance data for Supply Air, as tested on an AMCA Certified chamber.
 - 3. Motor ratings, electrical characteristics and motor and fan accessories.
 - 4. Performance ratings for DX coils.
 - 5. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 - 6. Estimated gross weight of each installed unit.
 - 7. Installation, Operating and Maintenance manual (IOM) for each model.
 - 8. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.
 - 9. Remote Panel description to include all functions
 - 10. AHRI Certified coil performance ratings with system operating conditions indicated. Ratings shall be in accordance with Standard 410.
 - 11. Color chart including a palette of available standard paint finishes.
 - 12. Energy wheel performance data for both summer and winter operation.

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. ARI Compliance: Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Rating Air-to-Air Energy Recovery Equipment."

- C. ASHRAE Compliance:
 - 1. Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
 - 2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."
- D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.
- E. UL Compliance: UL 1812.

1.5 COORDINATION

- A. Coordinate layout and installation of air-to-air energy recovery equipment 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.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY – ROOF MOUNTED

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck
 - 2. American Energy Exchange, Inc.
 - 3. Des Champs Technologies.
 - 4. SEMCO Incorporated.
 - 5. Venmar CES Inc.
 - 6. Daikin
 - 7. Trane
- B. General
 - 1. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, exhaust air blower, evaporator coil, energy wheel, hot gas reheat coil, indirect gas-fired furnace, packaged DX system, phase and brownout protection, motorized dampers, filter assembly intake air, supply air blower assembly, exhaust/relief blower assembly, filter assembly for exhaust air, and an electrical control center.
 - 2. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection.

C. Cabinet

1. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
2. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653.
3. Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
4. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Fiberglass insulation.
 - b. Thickness: 2 inch minimum.
 - c. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
5. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge galvanized G90 steel or painted galvanized steel.

D. Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 disposable pleated filters shall be provided in the supply final air stream and MERV 8 filters in the exhaust air stream.

E. Supply & Exhaust Air blower assemblies: Blower assembly shall consist of an electric motor and a direct-drive fan. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor shall be capable of continuous speed modulation and controlled by a VFD.

1. Blower section construction, Supply Air: direct drive (belt drive not permitted) motor and blower shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.
2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
3. Fan: Direct-drive airfoil plenum fan statically and dynamically balanced, AMCA certified for air and sound performance, mounted on ground and polished steel fan shafts with ball bearing pillow blocks. Bearings shall be selected for a minimum L10 life in excess of 50,000 hours at maximum catalogued speeds.
4. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating."
5. Blower motors shall be "NEMA Premium™". Compliance with EPA minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure

F. Evaporator Coil: Evaporator coil shall be AHRI Certified and shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins and enclosed in a galvanized steel frame. If two compressors are used as components of the unit, then the evaporator coil shall be of "interlaced"

configuration, permitting independent operation of either compressor without conflict with the other compressor.

1. The evaporator and condenser coils shall be coated with ElectroFin® coil coating.
- G. Condensate drain pan: Drain Pan shall be an integral part of the unit. Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P-trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.
1. A P-trap kit shall be provided with the unit.
- H. Control panel / connections: Rooftop Ventilator units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.
1. RTU shall be equipped with a factory-installed unit disconnect switch.
- I. Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and is designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.
1. Modulating frost control. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence.
- J. Reheat Coil with factory installed modulating hot gas reheat valve. The reheat coil is for humidity control and is connected to the compressor. This coil is coated with ElectroFin® coil coating.
- K. Indirect gas furnace:
1. Shall be ETL Certified as a component of the unit.
 2. Shall have an integral combustion gas blower.
 3. Shall be ETL Certified for installation downstream of a cooling coil.
 4. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.
 5. Shall have 4-pass tubular heat exchangers, constructed of type 409 stainless steel. Heat exchanger tubes shall be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes.
 6. Heat exchanger shall have a 10 year extended warranty.

7. Furnace control shall be 4:1 Modulating
 8. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly, and exhaust blower.
 9. Shall have solid state controls permitting stand-alone operation or control by building controllers.
- L. Packaged DX System: unit shall have an integral compressors and evaporator coil located within the weather-tight unit housing.
1. The evaporator and condenser coils are coated with ElectroFin® coil coating.
 2. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit and mounted on the exterior of the unit. Condenser fan motors shall be three phase, type 56 frame, Open Air Over and Shaft Up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Motors shall be UL Recognized and CSA Certified.
 3. The refrigerant compressors shall be digital hermetic scroll-type and shall be equipped with liquid line filter drier, thermostatic expansion valves, manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant.
 4. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.
- M. Motorized dampers / Intake Air Exhaust Air: Motorized damper of insulated low leakage type shall be factory installed.
- N. Sensors are considered to be part of various optional operational modes or device controllers and shall be factory supplied and installed.
- O. Curb Assembly: A curb assembly made of 14 gauge galvanized steel shall be provided by the factory for assembly and installation as part of this division. The curb assembly shall provide perimeter support of the entire unit and shall have duct adapters for supply air and return air. Curb assembly shall enclose the underside of the unit and shall be sized to fit into a recess in the bottom of the unit. Contractor shall be responsible for coordinating with roofing contractor to ensure curb unit is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly. The curb shall be as scheduled.
1. ERU-B sits on a roof curb.
 2. ERU-A sits on steel dunnage, bottom of ERU-A must be insulated with 2" thick minimum factory insulation.
- P. Vapor Tight Lights: Provide service lights mounted in the unit to be used during times of routine maintenance. The lights must be wired by others on the jobsite, as they will not be wired through the unit control center.
- Q. Unit Controls
1. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors. This unit shall

- be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.
2. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.
- R. Microprocessor Controller Sequence of Operation: Controller shall be provided with required sensors and programming for rooftop unit. Controller shall be factory programmed, mounted and tested.
1. UNIT START COMMAND:
 - a. Factory mounted and wired damper actuators are powered.
 - b. Exhaust fan starts after a 10 second (adjustable) delay.
 - c. Supply fan starts 5 seconds (adjustable) after exhaust fan.
 - d. Tempering options and energy wheel option to function as described below.
 2. UNIT STOP COMMAND (OR DE-ENERGIZED):
 - a. Supply fan, exhaust fan, energy wheel and tempering options de-energized.
 - b. Outdoor air damper actuator is spring return close, and the recirculated air damper actuator is spring open.
 3. OCCUPIED/UNOCCUPIED MODES: Shall be based on a 7-day time clock internal to the controller. The schedule shall be set by the end user. When a user initiates an override input, the DDC would switch from unoccupied to occupied mode. The DDC will return to the scheduled occupied/unoccupied mode after the override time has expired (60 min, adjustable). If internal time clock is disabled, a remote contact or a BAS can control the occupied/unoccupied mode.
 - a. ERU-A shall run constantly 24/7, providing ventilation to the apartments.
 - b. ERU-B shall have an occupied/unoccupied cycle, using the controller's internal time clock or a BAS signal. Unoccupied mode: Unit shall be OFF.
 - c. Occupied Mode:
 - 1) Supply fan ON.
 - 2) Exhaust fan ON.
 - 3) Energy wheel control per below.
 - 4) Heating per below.
 - 5) Cooling per below.
 - 6) Damper control per below.
 - d. Unoccupied Mode (Unit Off).
 - 1) Supply fan OFF
 - 2) Exhaust fan OFF
 - 3) Tempering OFF

- 4) Outdoor air damper closed
- 5) Exhaust damper closed

4. SUPPLY BLOWER SEQUENCE

- a. The supply blower is provided with a factory mounted variable frequency drive.
- b. Constant Volume (on/off): The supply blower is provided with a factory mounted VFD, and is intended to operate at a constant speed (adjustable set point in controller) during operation. This speed needs to be set during test and balance of the unit.

5. EXHAUST BLOWER SEQUENCE:

- a. The exhaust blower is provided with a factory mounted variable frequency drive.
- b. Constant Volume (on/off): The exhaust blower is provided with a factory mounted VFD, and is intended to operate at a constant speed (adjustable set point in controller) during operation. This speed needs to be set during test and balance of the unit.

6. COOLING SEQUENCE:

- a. Room Temperature and Dehumidistat: Factory provided, field mounted that is intended to monitor both the temperature and humidity level in the space. The controller will adjust the discharge temperature to try and meet a desired room temperature. If the humidity gets too high the after-cooling coil set point will be lowered to the minimum set point to further “dry” the supply air entering the space. Once the room dehumidistat is satisfied, the cold coil set point will return to the maximum setting.
- b. The mechanical cooling will be locked out when the outside air is < 55 F - 2 F hysteresis, adjustable.
- c. From 10-50%, the digital scroll will be controlled to maintain the discharge temperature.
- d. From 50-100%, the second stage will be on in combination with the digital scroll compressor to maintain the discharge temperature.

7. DEHUMIDIFICATION SEQUENCE:

- a. The cooling is controlled to maintain the cooling-coil set point.
- b. The dehumidification sequence will be locked out when the OA is <10 F above the cold-coil set point.
- c. The mechanical cooling will be locked out when the outside air is < 55 F - 2 F hysteresis, adjustable.
- d. DDC will provide a modulating signal for dehumidification.
- e. From 10-50%, the digital scroll will be controlled to maintain the after-coil temperature.
- f. From 50-100%, the second stage will be on in combination with the digital scroll compressor to maintain the after-coil temperature.

8. REHEAT SEQUENCE: While the unit is in dehumidification mode, the outdoor air can be reheated via Primary Heating Source or Modulating Hot Gas Reheat for Space Neutral Applications.

- a. Primary Heating Source: The main heating source is enabled to reheat the air to meet the room temperature set point (adj.).
 - b. Modulating Hot Gas Reheat: The controller will modulate the hot gas reheat valve with a 0-10 V signal to maintain the room temperature set point (adj.).
9. HEATING SEQUENCE:
- a. The heating is controlled to maintain the room temperature set point. The heating will be locked out when the outside air is $> 70\text{ F} + 2\text{ F}$ hysteresis, adjustable.
 - b. Indirect Gas Furnace: DDC will operate the indirect gas furnace to maintain the room temperature set point (adj.).
10. SUPPLY SET POINT RESET FUNCTION. Room temperature sensor will determine the supply temperature of the unit.
11. BUILDING FREEZE PROTECTION: If the supply air temperature drops below 35 F (adjustable), the DDC will de-energize the unit and activate the alarm output after a preset time delay.
12. FROST CONTROL:
- a. The DDC controller will output a signal when frosting is occurring which is determined by a temperature set point ($\text{OA} < 5\text{F} - 2\text{F}$ hysteresis, adjustable) and a pressure setpoint.
 - b. Modulate Wheel: When frosting is occurring, the VFD modulates the wheel down to a slow rotational speed to defrost wheel. Once the pressure drop decreases below the set point, frost mode is de-energized and the wheel returns to full speed.
13. ECONOMIZER SEQUENCE:
- a. When the application requires cooling, and the outdoor air conditions are suitable for free cooling, the microprocessor can control the wheel for free cooling. If the discharge temperature is not being met, the controller will start to increase the call for cooling to meet the discharge temperature and this could engage the mechanical cooling.
 - b. Dew Point/Dry Bulb: The economizer will be locked out when: the outside air is $< 40^{\circ}\text{F DB}$ ($- 2^{\circ}\text{F}$ hysteresis, adjustable) or $> 75^{\circ}\text{F DB}$ ($- 2^{\circ}\text{F}$ hysteresis, adjustable) or $> 55^{\circ}\text{F}$ dew point ($- 2^{\circ}\text{F}$ hysteresis, adjustable); the unit is operating in dehumidification mode; or there is a call for heating.
14. ENERGY WHEEL SEQUENCE
- a. Modulate Wheel (100% OA only): When economizer mode is enabled and there is a signal for cooling, the wheel VFD modulates wheel speed to maintain the discharge temperature set point.
 - b. The unit will be provided with energy wheel bypass dampers for both the outdoor air and return airstreams. During normal operation, the dampers shall remain closed to allow full operation of the energy wheel. During economizer sequences, the bypass dampers will be open to alleviate pressure drop through the wheel, while allowing more outdoor air to be used for economizer cooling.

15. ALARMS INDICATION: DDC shall have one digital output for remote indication of an alarm condition. Possible alarms include:
 - a. Dirty Filter Alarm: If the outside air or return air filter differential pressure rises above the switch set point
 - b. (adj.), the differential pressure switch shall signal the DDC to activate an alarm.
 - c. Dirty Wheel Alarm: DDC monitors pressure across the wheel and sends an alarm in the case of an increased pressure drop.
 - d. Wheel Rotation Alarm: Monitors wheel rotation, and sends a signal to controller (after a 15 second time delay with no rotation) that signals the DDC to activate an alarm.
 - e. Supply and Exhaust Air Alarm: DDC monitors proving switch on each blower and displays an alarm in case of blower failure.
 - f. DX Alarm: DDC monitors the refrigerant pressure and shuts off refrigeration circuit in the case of high or low refrigerant pressure.
 - g. Temperature Sensor Alarm: DDC will send an alarm in the case of a failed air temperature sensor.
 - h. Pressure Sensor Alarm: DDC will send an alarm in the case of a failed pressure sensor.
 - i. Humidity Sensor Alarm: DDC will send an alarm in the case of a failed humidity sensor.

16. Optional Accessories: The following accessories shall be provided to expand the functionality or usability of the controller.
 - a. DDC Remote Interface: An interface panel that can be wired to the main controller for remote adjustments of set points.
 - b. Phase and Brown-Out Protection: Factory mounted and wired component which monitors the main power coming into the unit. If a phase drops out or exceeds the limitations, or if the incoming voltage exceeds the acceptable range, the component will turn off the unit to help protect the electrical systems.
 - c. Operating protocol: The DDC shall be factory-programmed for BACnet IP.
 - d. Provide a room temperature sensor for each unit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb, ERU-B: Install on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7. Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing with anchor bolts.
- B. ERU-A: mount on steel dunnage. Unit must have an insulated bottom. Insulate ducts from unit to down through a roof curb.
- C. Install units with clearances for service and maintenance.
- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

- A. Provide condensate drain, minimum connection size, with trap per manufacturer's recommendations.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Gas Piping: Comply with applicable requirements in Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
 - 1. Provide natural gas piping per NFPA 54.
 - 2. An additional regulator shall be provided to reduce the pressure below 14" WC.
 - 3. Provide a gas cock with bleeder valve or 1/8" plugged tap.
 - 4. Provide an 8" trap leg.
 - 5. Provide a ground joint union.
- D. Comply with requirements for ductwork specified in Division 23 Section "Ductwork." Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Duct connections to and from units should allow straight, smooth airflow transitions. Avoid any abrupt change in duct size and sharp turns in the fan discharge. Avoid turns opposed to wheel rotation since they generate air turbulence and result in unwanted sound.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Pre-Start-Up Checklist
 - 1. Disconnect and lock-out all power switches.
 - 2. Remove any foreign objects that are located in the unit.
 - 3. Check all fasteners, set-screws, and locking collars on the fans, bearings, drives, motor bases and accessories for tightness.
 - 4. Rotate the fan wheels and energy recovery wheels by hand and ensure no parts are rubbing.
 - 5. Filters can load up with dirt during building construction. Replace any dirty pleated filters and clean the aluminum mesh filters in the intake hood.
 - 6. Verify that non-motorized dampers open and close properly.
 - 7. Check the tightness of all factory wiring connections.
 - 8. Verify control wire gauge.
 - 9. Verify diameter seal settings on the energy recovery wheel.
 - 10. Verify proper drain trap installation.
 - 11. Check condensing fans for any damage or misalignment. Spin the blades and make sure they don't contact any parts and are free turning without any resistance.
 - 12. Look over the piping system.
 - 13. Inspect all coils within the unit. Fins may get damaged in transit or during construction. Carefully straighten fins with a fin comb.
 - 14. This unit contains a crankcase heater for each compressor which needs power supplied to it 24 hours prior to start-up. If start-up is scheduled in 24 hours, unlock the disconnect power and energize unit.
- C. Perform tests and inspections: Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Adjust seals and purge.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 4. Set initial temperature and humidity set points.
 - 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- E. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 23 72 00

SECTION 23 74 13 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units.
 - 1. RTU-1 – Auditorium
 - 2. MUA-1 – Bistro

1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: To include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of filters for each unit.

1.6 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with ARI 270 for testing and rating sound performance for units.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.

2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin
 2. Trane
 3. York
 4. Carrier

2.2 GENERAL DESCRIPTION

- A. Furnish as shown on plans, Daikin Applied Rebel single zone heating and cooling units Model DPS. Unit performance and electrical characteristics shall be per the job schedule.
- B. RTU-1 Configuration: Fabricate as detailed on prints and drawings:
1. Return plenum / economizer section
 2. Filter section
 3. Cooling coil section
 4. Supply fan section

5. Gas heating section.
 6. Condensing unit section
- C. MUA-1 Configuration: Fabricate as detailed on prints and drawings:
1. Intake
 2. Filter section
 3. Cooling coil section
 4. Supply fan section
 5. Gas heating section.
 6. Condensing unit section
- D. The complete unit shall be cETLus listed.
- E. The unit shall be ASHRAE 90.1-2013 compliant and labeled.
- F. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.
- G. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- H. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
- I. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

2.3 CABINET, CASING, AND FRAME

- A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
- B. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- C. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

- D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.4 INTAKE SECTION (MUA-1)

- A. Unit shall be provided with an outdoor air section with outdoor dampers.
- B. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream.
- C. The outside dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500.
- D. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type.

2.5 ECONOMIZER SECTION (RTU-1)

- A. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
- B. Provide barometric relief.
- C. Provide a field installed Duct-mounted CO2 sensor. Outside air damper position will modulate between the Demand Control Ventilation Limit (zero-CFM minimum position setpoint – Note: minimum ventilation is supplied from ERU-B) and the Ventilation Limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position will be controlled to the greater of the two command signals, either minimum outside air flow or space IAQ (CO2).

2.6 FILTERS

- A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of MERV-8 pre-filters.

2.7 COOLING COIL

- A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
- B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
- E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.8 HOT GAS REHEAT

- A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser
- B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
- C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.

- D. Each coil shall be factory leak tested with high-pressure air under water.

2.9 SUPPLY FAN

- A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft.
- B. Fan assembly shall be a slide out assembly for servicing and maintenance
- C. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- D. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- E. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.10 VARIABLE AIR VOLUME CONTROL

- A. The unit controller shall proportionally control the Electronically Commutated Motors (ECM) on the supply fan.
- B. The unit controller shall provide discharge air temperature control with the compressor modulation.
- C. RTU-1: The unit controller shall proportional control the ECM motors on the supply fan based on space temperature. The unit controller shall increase/decrease the speed of the supply fan in order to maintain the space temperature within its setpoint and deadband.
- D. MUA-1: The supply fan shall be controlled to maintain an adjustable airflow as required by the kitchen hood DCV controller. Provide control interface with the hood controller and Building Automation System, see Section 230993.

2.11 HEATING SECTION

- A. The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
- B. The module shall be complete with furnace controller and control valve capable of 5:1 modulating operation.
- C. The heat exchanger tubes shall be constructed of stainless steel.

- D. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
- E. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
- F. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

2.12 CONDENSING SECTION

- A. Outdoor coils shall have seamless copper tubes, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- B. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0 to 125°F. Mechanical cooling shall be provided to 25° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- C. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
- D. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature.
- E. Provide compressor suction and discharge isolation valves.
- F. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- G. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
- H. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

2.13 ELECTRICAL

- A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
- B. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

2.14 CONTROLS

- A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All controllers and sensors shall be factory mounted, wired and tested.
- B. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or BAS for proper unit operation. The microprocessor shall maintain existing set points and operate stand-alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip
- E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.

- F. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

1. Return air temperature.
2. Discharge air temperature.
3. Outdoor air temperature.
4. Space air temperature.
5. Outdoor enthalpy, high/low.
6. Compressor suction temperature and pressure
7. Compressor head pressure and temperature
8. Expansion valve position
9. Condenser fan speed
10. Inverter compressor speed
11. Dirty filter indication.
12. Airflow verification.
13. Cooling status.
14. Control temperature (Changeover).
15. Cooling status/capacity.
16. Unit status.
17. All time schedules.
18. Active alarms with time and date.
19. Previous alarms with time and date.
20. Optimal start
21. Supply fan and exhaust fan speed.
22. System operating hours.
 - a. Fan
 - b. Cooling
 - c. Individual compressor
 - d. Heating
 - e. Economizer
 - f. Tenant override

- G. The user interaction with the keypad shall provide the following:

1. Controls mode
 - a. Off manual
 - b. Auto
 - c. Heat/Cool
 - d. Cool only
 - e. Heat only
 - f. Fan only
2. Occupancy mode
 - a. Auto
 - b. Occupied

- c. Unoccupied
 - d. Tenant override
 3. Unit operation changeover control
 - a. Space temperature
 4. Cooling and heating change-over temperature with deadband
 5. Cooling discharge air temperature (DAT)
 6. Supply reset: based on space temperature
 7. Temperature alarm limits
 - a. High supply air temperature
 - b. Low supply air temperature
 - c. High return air temperature
 8. Lockout control for compressors.
 9. Compressor inter-stage timers
 10. Night setback and setup space temperature.
 11. Building static pressure.
 12. Economizer changeover: Enthalpy
 13. Currently time and date
 14. Tenant override time
 15. Occupied/unoccupied time schedule
 16. One event schedule
 17. Holiday dates and duration
 18. Adjustable set points
 19. Service mode
 - a. Timers normal (all time delays normal)
 - b. Timers fast (all time delays 20 sec)
- H. Space sensors shall be provided to support field selectable features. Sensor options shall include:
 1. Zone sensor with tenant override switch plus heating and cooling set point adjustment.
- I. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
 1. Airflow
 2. Outside air temperature
 3. Space temperature
 4. Return air temperature

2.15 ROOF CURB

- A. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.
- B. Curb Height as scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of units.
- B. Examine roughing-in for units to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.
- B. Provide acoustical treatments as recommended by manufacturer.

3.3 CONNECTIONS

- A. Provide condensate drain, minimum connection size, with trap per manufacturer's recommendations.
- B. Install piping adjacent to units to allow service and maintenance.
- A. Gas Piping: Comply with applicable requirements in Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
 - 1. Provide natural gas piping per NFPA 54.
 - 2. An additional regulator shall be provided to reduce the pressure below 14" WC.
 - 3. Provide a gas cock with bleeder valve or 1/8" plugged tap.

4. Provide an 8" trap leg.
 5. Provide a ground joint union.
- B. Comply with requirements for ductwork specified in Division 23 Section "Ductwork." Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
1. Install ducts to termination at top of roof curb.
 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 3. Install return-air duct continuously through roof structure.
 4. Duct connections to and from units should allow straight, smooth airflow transitions. Avoid any abrupt change in duct size and sharp turns in the fan discharge. Avoid turns opposed to wheel rotation since they generate air turbulence and result in unwanted sound.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. 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. Report results in writing.
- C. Tests and Inspections:
1. After installing units and after electrical circuitry has been energized, test units for compliance with requirements.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 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.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
 2. Inspect for visible damage to furnace combustion chamber.

3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
17. Inspect and record performance of interlocks and protective devices; verify sequences.
18. Operate unit for an initial period as recommended or required by manufacturer.
19. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

25. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
26. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Economizer to minimum outdoor-air changeover.
27. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. 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 site during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 74 13

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 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. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 COORDINATION

- A. Coordinate sizes and locations of equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

- A. This warranty applies to parts only and is limited in duration to five (5) years from the earlier to occur of (a) the date of original installation, whether or not actual use begins on that date, or (b) eighteen (18) months from the date of shipment. Customer must present proof of the original date of receipt and of installation of the Product in order to establish the effective date of this warranty. Repaired or replacement parts are warranted for the balance of the warranty period applicable to the original part following the date on which the repaired or replacement part is provided to the Customer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin
 - 2. Mitsubishi
 - 3. Sanyo
 - 4. Trane
 - 5. Fujitsu
 - 6. Samsung

2.2 DUCTLESS SPLITS

- A. The variable capacity, heat pump air conditioning system shall be a Daikin Inverter Driven series (heat/cool model) split system. The system shall consist of indoor evaporators matched to outdoor models.
- B. Single split units shall be exclusively matched to an outdoor unit.
- C. Multi splits have more than one indoor unit matched to an outdoor unit.
- D. Quality Assurance
 - 1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
 - 2. All wiring shall be in accordance with the National Electric Code (NEC).
 - 3. Each combination shall be rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210/240 and bear the ARI label.

4. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
5. The outdoor unit will be factory charged for a length of 33 feet of refrigerant with R-410A refrigerant.
6. A holding charge of dry nitrogen shall be provided in the evaporator.
7. System efficiency shall meet or exceed: -
8. Unit shall be stored and handled according to the manufacturer's recommendations.

E. Indoor Unit

1. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. The system shall have automatic restart capability after a power failure has occurred and a low voltage cut-off feature to prevent stalling during power supply issues.
3. Unit Cabinet:
 - a. The indoor unit shall have a white, "flat screen" finish.
 - b. Quiet operation down to 25 dBA sound pressure level
4. Wall units:
 - a. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
 - b. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom).
 - c. An auto-swing louver for adjustable air flow (both vertically and horizontally) is standard via the wireless remote control furnished with each system.
5. Ceiling Cassettes:
 - a. Built in condensate lift pump, up to 22" lift.
 - b. Designed to fit in a 2x2 ceiling grid.
 - c. Airflow can be sent in any of four directions and the user has the ability to shut down one or two sides so the cassette can be easily installed in a corner.
 - d. Vertical auto-swing function moves the discharge flaps up and down for efficient air distribution throughout the room
 - e. Any one of 5 air flow patterns can be freely selected between zero and 40 degrees and will then be maintained during the operational cycle of the air conditioner.
6. Fan:
 - a. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
 - b. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
 - c. The indoor fan shall offer a choice of five speeds, plus quiet and auto settings.

7. Filter: The return air filter provided will be a mildew proof, removable and washable filter.
8. Coil:
 - a. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
 - b. All tube joints shall be brazed with silver alloy or phoscopper.
 - c. All coils will be factory pressure tested.
 - d. A condensate pan shall be provided under the coil with a drain connection.
9. Electrical:
 - a. The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.
 - b. The allowable voltage range shall be 187 volts to 253 volts.
10. Control: The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the thermostat. Coordinate with Sections 230900 and 230993.

F. Outdoor Unit

1. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls.
2. Unit Cabinet: The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
3. Fan:
 - a. The fan shall be a direct drive, propeller type fan.
 - b. The motor shall be inverter driven, permanently lubricated type bearings, inherent.
 - c. The fan shall be capable of operating in "quiet outdoor operation" which lowers the outdoor fan speed in either cool, heat or auto modes.
 - d. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
 - e. Airflow shall be horizontal discharge.
4. Coil:
 - a. The outdoor coil shall be nonferrous construction with corrugated fin tube.
 - b. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
 - c. Refrigerant flow from the condenser will be controlled via a metering device.
5. Compressor:
 - a. The compressor shall be an inverter-driven compressor.
 - b. The outdoor unit shall have an accumulator and four-way reversing valve.
 - c. The compressor shall have an internal thermal overload.

- d. The outdoor unit can operate with a maximum vertical height difference of 66 feet and overall maximum length of 98 feet without any oil traps or additional components.
6. Electrical:
 - a. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
 - b. The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts.
 - c. The outdoor shall be controlled by a microprocessor located in the outdoor and indoor units via commands from the infrared remote controller.
 - d. Dedicated EEV's shall be provided for capacity control during part load of the indoor unit.
 7. Provide accessories
 - a. Wall mounted CU's: Provide mounting bracket. Rectorseal Model WBB300 powder coat; 300# capacity, sliding cross bar for adjustment.
 - b. Floor or concrete pad mounted: Bolt per manufacturers recommendations.
 - c. Roof: Mount on sleepers, securely fastened to the roof. CU's shall be bolted/fastened, gravity support only is not acceptable.
 - d. Provide air adjustment grille for CU's on porches.

2.3 LINE SETS

- A. PDM Preinsulated Pipes; "Gelcopper" or approved equal.
- B. Length: 50 foot rolls.
- C. Polyethylene closed cell foam: assures thermal insulation from surroundings.
 1. ASTM C 1427-07 compliant
 2. Type I (tubular)
 3. Grade I (insulation material for use on typical commercial system non-crosslinked).
 4. Low-density polyethylene foam: closed cells foam, CFC and HCFC gas free
 5. Water vapor permeability: ASTM E96-00 compliant
 6. Working temperature: ASTM C 1427-07 compliant
 7. Wall thickness: 1/2" and 3/4"
 8. Surface burning characteristics: UL 94, top rated – UL 723,
 9. ASTM E84 (25/50) compliant, flame and Spread Index less than 25 and Smoke Development Index less than 50 as tested according to UL 723.
 10. R-Value: between 6.0 and 3.0 (depending on pipe diameter)
- D. Copper
 1. Pipes: Manufactured according to ASTM B280
 2. Copper: No. C122200 DHP (phosphorous deoxidized, high residual phosphorous), 99.90%.

- E. Outer Jacket: Additional white polyethylene jacket cover protects foam insulation from tearing during installation process.
- F. Marking: insulation incrementally marked by every foot to ensure accurate initial unit charge.
- G. R410a approved: Gelcopper can be used in applications where high-pressure gases are used as refrigeration source.
- H. UV resistant: Gelcopper is UV resistant.
- I. Paintable: The insulation can be painted to match the surroundings.

2.4 ACCESSORIES

- A. Drain Hose: Rectorseal DSH pre-insulated drain hose, complete with hose couplers and PVC pipe adapters.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide in accordance with manufacturers recommendations.
- B. Provide components using manufacturer's standard mounting devices securely fastened to building structure. Provide units level and plumb.
- C. Condensing units shall be installed with minimum clearances per manufactures' recommendations.
- D. Provide and connect pre-charged refrigerant tubing to component's quick-connect fittings. Provide tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Route 1" indoor unit condensate drains to sink traps, floor drains, plumbing code compliant, or other locations as indicated.
- C. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. 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. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 82 33 - CONVECTION HEATING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hydronic finned-tube radiators.

1.3 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.
 - 1. Plans, elevations, sections, and details.
 - 2. Details of custom-fabricated enclosures indicating dimensions.
 - 3. Enclosure joints, corner pieces, access doors, and other accessories.
- C. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.

1.4 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. Factory test and rate finned-tube radiators according to Hydronic Institute's "Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
- C. Performance Ratings: Rate according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

PART 2 - PRODUCTS

2.1 LOW-TEMP RESIDENTIAL FIN TUBE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Sterling - Design Line Synergy
 - 2. Smith's Environmental Products
- B. Low temperature baseboard designed to operate efficiently with 140°F HWS.
- C. All Synergy enclosures are manufactured using durable 18 gauge steel panels with a white baked enamel finish. Individual room temperature control made easy through finger-touch adjustable dampers
- D. Provide "easy-glide" expansion cradles for noise free operation. Provide "easy-glide" cradles for return piping installations.
- E. The three piece, snap-in "EZ Hanger" back plate, coil and cover design shall eliminate all carriers, brackets, cradles, dampers, damper vents and miscellaneous hardware.
- F. Copper & aluminum heating elements are mechanically bonded and incorporate expanded ends for easy sweat connections without couplings.
- G. Provide accessories as required for specific installation
 - 1. End caps – telescopic, provide finished ends.
 - 2. Extension sets – to fill gaps between connected baseboards.
 - 3. Wall joiners – provide telescoping ends to conceal connecting pipes.
 - 4. Inside corners
 - 5. Outside corners

2.2 COMMERCIAL HOT-WATER FINNED-TUBE RADIATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Sterling
 - 2. Rittling
 - 3. Slant/Fin.
 - 4. Trane.
 - 5. Vulcan
- B. Furnish and install where shown on all plans, Sterling Versa-Line Finned-Tube or approved equal quality and capacity.

- C. Heating Elements as scheduled:
 - 1. Seamless copper tubing suitable for soldered fittings, mechanically expanded into evenly spaced aluminum fins.
 - 2. Tube Diameter: as scheduled.
 - 3. Fin Size: as scheduled.
- D. Partial back plates shall be machine roll formed, pre-painted, 20-gauge steel with formed mounting channel into which the enclosure shall self-locate and secure.
- E. All brackets and hangers shall be die-formed 14-gauge galvanized steel with channel type wiped edge construction for rigidity. Nickel-chromium plated ball bearings inserted into a nylon isolator insert shall be used in conjunction with an 18 gauge galvanized die-formed element support cradle to provide friction free lateral movement during expansion and contraction. Brackets shall have pre-formed contour at the top allowing the bracket to interlock with the back plate channel. Brackets shall be self-locating in the vertical (height) position. Full engagement enclosure locks are to be supplied with each bracket.
- F. Hangers shall provide for vertical element adjustment when pitch is required. Water applications do not require adjustable hangers.
- G. Finned-tube enclosures
 - 1. Style and size as scheduled.
 - 2. Enclosure Style:
 - a. JVB-FT: square top with front & top outlet
 - b. JVB-PM: pedestal mount
 - 3. Material shall be 16-gauge cold rolled steel with baked primer suitable for field painting.
 - 4. Air discharge and/or inlet louvers shall be "pencil proof."
 - 5. Welded male and female slip joints shall be provided at each end to allow for positive engagement and alignment of adjoining enclosures.
 - 6. Internal 14 gauge gussets (minimum of two) shall be welded into place at ends of each enclosure style and design configuration.
 - 7. All bends (lateral) on enclosure are to be formed on bottoming dies to ensure continuity of all adjoining enclosures and accessories.
 - 8. Finish: Factory-applied baked enamel in manufacturer's standard color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for hydronic-piping connections to verify actual locations before convection heating unit installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FINNED-TUBE RADIATOR INSTALLATION

- A. Install units level and plumb.
- B. Install finned-tube radiators according to Guide 2000 - Residential Hydronic Heating.
- C. Install enclosure continuously around corners, using outside and inside corner fittings.
- D. Join sections with extension sets to provide continuous enclosure.
- E. Install access doors for access to valves.
- F. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."
- C. Install control valves as required by Division 23 Section "Instrumentation and Control for HVAC."
- D. Install piping adjacent to convection heating units to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 23 82 33

SECTION 23 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

- A. This Section includes:
 - 1. Unit heaters.
 - 2. Cabinet unit heaters
 - 3. Kick space heaters

1.3 SUBMITTALS

- A. Product Data: Include specialties and accessories for each unit type and configuration.
 - 1. Plans, elevations, sections, and details.
 - 2. Power, signal, and control wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.
 - 3. Equipment schedules to include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
 - 4. Cabinet Unit Heater color samples for initial selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- B. Maintenance Data: For unit heaters to include in maintenance manuals specified in Division 1. Include maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.4 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.

1.5 COORDINATION

- A. Coordinate layout and installation of unit heaters and suspension system components
- B. Coordinate wall construction and conditions with recessed or semi-recessed cabinet unit heater installation requirements.

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. Cabinet Unit Heater Filters: Furnish one set of spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corp.
 - 2. Trane
 - 3. Daikin
 - 4. Sterling
 - 5. Vulcan
 - 6. Modine
 - 7. Beacon Morris

2.2 CABINET UNIT HEATERS

- A. Description: An assembly including filter, chassis, coil, fan, and motor in blow-through configuration with heating coil.
- B. Cabinet: Configuration as scheduled.
- C. Chassis: Galvanized steel, with flanged edges and unit-leveling bolts.
- D. Coil Section Insulation: 1-inch duct liner complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. Fire-Hazard Classification: Duct liner and adhesive shall have a maximum flame-spread rating of 25 and smoke-developed rating of 50 when tested according to ASTM E 84.
- E. Cabinet: Galvanized steel, with removable panels.
- F. Cabinet Finish: Cabinet parts and exposed recessed panels shall be cleaned, bonderized, phosphatized, and painted with a baked powder finish available in six colors. Finish shall meet

ASTM B117 specifications (salt spray test). Submit color chart or web link to color chart for Architect approval.

- G. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and with manual air vent. Coils shall be rated for a minimum working pressure of 300 psig and a maximum entering water temperature of 275 deg F, with manual air vent.
- H. Filters: 1-inch- thick, pleated glass-fiber media in fiberboard frame, MERV 8.
- I. Fan: Centrifugal, with forward-curved, double-width wheels and fan scrolls made of galvanized steel or thermoplastic material; directly connected to motor.
- J. Motors shall be electronically commutated motors (ECM) factory-programmed and run-tested in assembled units. The motor controller shall be mounted in a touch-safe control box with a built-in integrated user interface and LED tachometer. If adjustments are needed, motor parameters can be adjusted through momentary contact switches accessible without factory service personnel on the motor control board. Motors shall soft-ramp between speeds to lessen the acoustics due to sudden speed changes. Motors shall be operated at three speeds. The motor will choose the highest speed if there are simultaneous/conflicting speed requests. Motors shall have integral thermal overload protection with a maximum ambient operating temperature of 104°F and shall be permanently lubricated. Motors shall be capable of starting at 50 percent of rated voltage and operating at 90 percent of rated voltage on all speed settings. Motors shall operate up to 10 percent over voltage.
- K. Accessories
 - 1. Steel recessing flanges for recessing cabinet unit heaters into ceiling or wall.
 - 2. Leveling feet for vertical floor mounted cabinet unit heaters.
 - 3. Control Devices: Unit-mounted fan-speed switch.
 - 4. Provide a unit-mounted disconnect switch.

2.3 UNIT HEATERS

- A. Description: An assembly including casing, coil, fan, and motor.
- B. Casing: Galvanized steel, with removable panels.
- C. Cabinet Finish: Bonderize, phosphatized, and flow-coat with baked-on primer and manufacturer's standard paint applied to factory-assembled and -tested propeller unit heater before shipping.
- D. Hot-Water Coil: Copper tube, 0.031-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering water temperature of 325 deg F, with manual air vent. Test for leaks to 375 psig underwater.
- E. Propeller with aluminum blades directly connected to motor.
- F. Fan Motors: shaded-pole or permanent-split capacitor, with integral thermal-overload protection.

- G. Units mounted shall be equipped with an OSHA fan guard. Fan guards shall be welded steel, zinc plated or painted.
- H. Accessories: Provide Disconnect switch

2.4 KICK SPACE HEATERS

- A. Beacon Morris TWIN-FLO III heaters designed for use with forced hot water residential heating systems and consist of a copper tube, aluminum finned heating element, with an electric motor and blower of unique cross flow design. Their purpose is to deliver a comfortable stream of warmed air, at or near floor level, and their construction is extremely compact so minimum space is required for installation.
- B. The type K heater is primarily used in horizontal floor installation, for example: under a kitchen counter cabinet, or bathroom sink enclosure. They are ideal for radiant systems with the use of a low temperature aquastat designed to turn the unit on at 110° F. Type
- C. Provide heating elements with 1/2" nominal (5/8 O.D.) copper tube connections, and 115V electric blower motor, inter-wired with a 120°F reverse acting aquastat that prevents operation until hot water is circulating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before cabinet unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install unit heaters level and plumb.
- B. Install unit heaters to comply with NFPA 90A.
- C. Hung unit heaters shall be suspended from structure with rubber-in-shear vibration isolators (rubber hangers).

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
- C. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and report results in writing:
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

- A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. After installing units, clean unit heaters internally according to manufacturers written instructions.
- C. Install new filters in each cabinet unit heater within two weeks after Substantial Completion.

END OF SECTION 23 82 39

SECTION 26 01 00 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. General requirements applicable to all Division 26 sections.
 - 2. Allowances for Utility Construction Charges

1.3 TEMPORARY POWER AND LIGHTING

- A. Provide a separately metered temporary electrical service for the construction area.
- B. Power Distribution: Provide weatherproof, grounded circuits with ground-fault interruption features, with proper power characteristics and either permanently wired or plug-in connections as appropriate for intended use. Provide overload-protected disconnect switch for each circuit at distribution panel. Space 4-gang convenience outlets (20 amp circuit) so that every portion of work can be reached with 100' extension cord.
- C. Temporary Lighting: Provide lighting of intensity and quality sufficient for proper and safe performance of the work and for access thereto and security thereof, minimum average illumination level in every room shall be 20 footcandles.

1.4 ALLOWANCES FOR UTILITY CONSTRUCTION CHARGES

- A. Provide a \$25,000 allowance as specified in Division 01 for electric utility company utility construction charges associated with the electric service.
- B. Provide a \$15,000 allowance as specified in Division 01 for electric utility company utility construction charges associated with the electric service.

1.5 GENERAL REQUIREMENTS APPLICABLE TO ALL DIVISION 26 SECTIONS

- A. Regulatory Requirements:
 - 1. Conform to the requirements of all laws and regulations applicable to the work.
 - 2. Conform to the requirements of Federal State and Municipal Building Codes.
 - 3. Cooperate with all authorities having jurisdiction.

4. Compliance with laws and regulations governing the work on this project does not relieve the Contractor from compliance with more restrictive requirements contained in these specifications.
5. If the Contract Documents are found to be at variance with any law or regulation, the Contractor shall notify the Architect/Engineer promptly in writing. The Contractor shall assume full responsibility for any work contrary to law or regulation, and shall bear all costs for the corrections thereof.
6. Minimum Requirements: The more stringent of the 2011 National Electrical Code (NEC) or the edition enforced by the local Authority Having Jurisdiction, Underwriters Laboratories, Inc. (UL), the National Fire Codes, and National Fire Protection Association (NFPA) are a minimum requirement for work under this section. Design drawings and other specification sections shall govern in those instances where requirements are greater than those required by code.

B. REFERENCES

1. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
 - a. National Fire Protection Association (NFPA).
 - b. National Electrical Code (NEC)
 - c. National Electrical Safety Code (NESC)
 - d. Underwriters Laboratories, Inc. (UL)
 - e. American National Standards Institute (ANSI)
 - f. Certified Ballast Manufacturers Association (CBM)
 - g. National Electrical Manufacturers Association (NEMA)
 - h. International Municipal Signal Association (IMSA)
 - i. Institute of Electrical and Electronic Engineers (IEEE)
 - j. American Society for Testing Materials Specifications (ASTM)
 - k. National Bureau of Standards Handbook (NBS)
 - l. Occupational Safety and Health Administration (OSHA)
 - m. Americans with Disabilities Act (ADA)
 - n. Insulated Power Cable Engineers Association Specifications (IPCEA)

C. Permits, Fees, and Inspections:

1. Secure and pay for all permits, fees, licenses, inspections, etc., required for the work under Division 26.
2. Schedule and pay for all legally required inspections and cooperate with inspecting officers.
3. Provide Certificates of Inspection and Approval from all regulatory authorities having jurisdiction over the work in Division 26.

D. The Contractor shall study all drawings and specifications and acquaint itself with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to familiarize itself with the conditions and extent of the proposed work.

E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

- F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

1.6 EFFICIENCY MAINE

- A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall be an Efficiency Maine Qualified Partner and shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive application(s) and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.
- B. The contractor shall also:
 - 1. Become familiar with the Efficiency Maine Business Program including available incentives and the application and review process.
 - 2. Review plans and specifications for any and all incentive opportunities, prescriptive and custom.
- C. The project schedule shall reflect and accommodate the time required to achieve application preapproval from EM. No equipment shall be purchased until preapproval is received from EM.
- D. All invoices shall be forwarded to EM within 60 days of the completion of work. This deliverable shall be shown on the project schedule as a milestone date and coordinated with all contractors to assure compliance with this requirement.
- E. Efficiency Maine is available to assist in the application process and can be reached at 866-376-2463

1.7 COORDINATION

- A. Provide coordination drawings in accordance with Section 01 00 00 "General Requirements".
- B. Coordinate the work of Division 26 with other Divisions, the Owner, and utility companies.
- C. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- D. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- E. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08.
- F. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION – Not Used

END OF SECTION 26 01 00

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

- A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Alpha Wire.](#)
 - 2. [Belden Inc.](#)
 - 3. [Encore Wire Corporation.](#)
 - 4. [General Cable Technologies Corporation.](#)
 - 5. [Southwire Incorporated.](#)
- B. Aluminum and Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2, Type XHHW-2, and Type SO.
- D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC; mineral-insulated, metal-sheathed cable, Type MI and type SO with ground wire.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Hubbell Power Systems, Inc.](#)
 - 2. [Ideal Industries, Inc.](#)
 - 3. [Iisco](#); a branch of Bardes Corporation.
 - 4. [NSi Industries LLC.](#)
 - 5. [O-Z/Gedney](#); a brand of the EGS Electrical Group.
 - 6. [3M](#); Electrical Markets Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

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

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - 1. Compression pin terminal adapters shall be used at terminations for aluminum conductors.
- B. Branch Circuits: Copper. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.

- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- E. Emergency System feeders: Mineral-insulated cable, Type MI.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
 - 1. Shall be MC cabling or shall be Type THHN-2-THWN-2 single conductors in raceway. Where infrastructure is exposed in areas without ceilings, MC cabling shall not be used.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- J. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. 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 Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly using materials listed for that purpose and installed according to their listing.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and emergency system feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 05 19

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. RS-485 cabling.
 - 2. Low-voltage control cabling.
 - 3. Control-circuit conductors.
 - 4. Identification products.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

2.2 PERFORMANCE REQUIREMENTS

- A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: **60 inches (1520 mm)** or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CMR.
 - 1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1685.

2.4 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMR.
 - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1685.

2.5 CONTROL-CIRCUIT CONDUCTORS

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

1. [Encore Wire Corporation.](#)
 2. [General Cable Technologies Corporation.](#)
 3. [Southwire Company.](#)
- B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.
- C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway complying with UL 83.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
1. Smoke control signaling and control circuits.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
1. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
- B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1 and NFPA 70.
- B. General Requirements for Cabling:
1. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 2. Cables may not be spliced.
 3. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems".
 5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
 7. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems". Monitor cable pull tensions.
- C. Installation of Control-Circuit Conductors:
1. Install wiring in raceways except at cable trays and telecommunications racks. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- D. Open-Cable Installation at cable trays and telecommunications racks:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
- E. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **12 inches (305 mm)**.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **24 inches (600 mm)**.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **12 inches (305 mm)**.
 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

- a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **3 inches (75 mm)**.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of **48 inches (1200 mm)**.
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.

3.3 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.4 FIRESTOPPING

- #### A. Comply with requirements in Division 07.

3.5 GROUNDING

- #### A. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

- #### A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
2. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified

in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 05 23

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum unless noted otherwise.
 - 1. Bury at least 24 inches (600 mm) below grade.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- C. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Cooper B-Line, Inc.; a division of Cooper Industries.](#)
 - b. [ERICO International Corporation.](#)
 - c. [Thomas & Betts Corporation.](#)
 - d. [Unistrut; Tyco International, Ltd.](#)
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

- 1) [Cooper B-Line, Inc.; a division of Cooper Industries.](#)
- 2) [Empire Tool and Manufacturing Co., Inc.](#)
- 3) [Hilti Inc.](#)
- 4) [ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.](#)
- 5) [MKT Fastening, LLC.](#)

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be **1/4 inch (6 mm)** in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb (90 kg)**.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than **4 inches (100 mm)** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use **3000-psi (20.7-MPa)**, 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. AFC Cable Systems, Inc.
 2. Alfex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. O-Z Gedney; a unit of General Signal.
 5. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.

- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel set-screw type.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corporation.
 - 4. CANTEX Inc.
 - 5. Carlon Electrical Products.
 - 6. RACO; a Hubbell Company.
 - 7. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. Fittings and RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY 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:

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arnco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
- C. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.

4. Hoffman.
 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 6. O-Z/Gedney; a unit of General Signal.
 7. RACO; a Hubbell Company.
 8. Thomas & Betts Corporation.
 9. Walker Systems, Inc.; Wiremold Company (The).
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast metal, rectangular. Basis of Design is FSR, Inc. FL-500P series.
1. Provide with pour pan for grade-level application where required.
 2. Provide with cover and trim as applicable to finished flooring.
 3. Trim and cover color as selected by Architect from manufacturers standard.
 4. Provide complete with all components required to create configurations indicated or scheduled on the drawings. Where empty floor boxes are indicated, provide blank internal device plates.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic finished inside with radio-frequency-resistant paint.
- I. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
- 2.7 SLEEVES FOR RACEWAYS
- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Concealed Conduit, Aboveground: Rigid steel conduit.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Vehicle loading/unloading areas.
 - b. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet Locations: Rigid steel conduit
 - 7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
 - 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, in damp or wet locations.
- C. Minimum Raceway Size: ¾ inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. 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.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than **1-inch (27-mm)** trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from ENT to RNC, rigid steel conduit, or IMC before rising above the floor.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than **200-lb (90-kg)** tensile strength. Leave at least **12 inches (300 mm)** of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 - 1. **3/4-Inch (19-mm)** Trade Size and Smaller: Install raceways in maximum lengths of **50 feet (15 m)**.

2. **1-Inch (25-mm)** Trade Size and Larger: Install raceways in maximum lengths of **75 feet (23 m)**.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed **30 deg F (17 deg C)**, and that has straight-run length that exceeds **25 feet (7.6 m)**.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F (70 deg C)** temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F (86 deg C)** temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: **125 deg F (70 deg C)** temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change.
 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- P. Set metal floor boxes level and flush with finished floor surface.
- ### 3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS
- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
 - B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 6 inches (50 mm) above finished floor level unless noted otherwise.
- H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
 - 2. Handholes and boxes.
 - 3. Manholes.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes.
 - 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Ladder details.
 - 5. Grounding details.
 - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.

- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- C. Qualification Data: For professional engineer and testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Owner no fewer than five days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.9 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 PRECAST CONCRETE HANDHOLES AND BOXES

- 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. [Carder Concrete Products.](#)
 2. [Christy Concrete Products.](#)
 3. [Elmhurst-Chicago Stone Co.](#)
 4. [Oldcastle Precast Group.](#)
 5. [Riverton Concrete Products; a division of Cretex Companies, Inc.](#)
 6. [Utility Concrete Products, LLC.](#)
 7. [Utility Vault Co.](#)
 8. [Wausau Tile, Inc.](#)
- B. Comply with ASTM C 858 for design and manufacturing processes.

- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 3. Cover Legend: Molded lettering, As indicated for each service.
 4. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 5. Extensions: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of **12 inches (300 mm)**.
 6. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
1. Color: Gray.
 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, As indicated for each service.
 6. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Armorcast Products Company](#).
 - b. [Carson Industries LLC](#).
 - c. [CDR Systems Corporation](#).
 - d. [NewBasis](#).

2.4 PRECAST MANHOLES

- 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. [Carder Concrete Products.](#)
 2. [Christy Concrete Products.](#)
 3. [Elmhurst-Chicago Stone Co.](#)
 4. [Oldcastle Precast Group.](#)
 5. [Riverton Concrete Products; a division of Cretex Companies, Inc.](#)
 6. [Utility Concrete Products, LLC.](#)
 7. [Utility Vault Co.](#)
 8. [Wausau Tile, Inc.](#)
- B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional **12 inches (300 mm)** vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than **6 inches (150 mm)** from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
- C. Concrete Knockout Panels: **1-1/2 to 2 inches (38 to 50 mm)** thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 UTILITY STRUCTURE ACCESSORIES

- 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. [Bilco Company \(The\).](#)
 2. [Campbell Foundry Company.](#)
 3. [McKinley Iron Works, Inc.](#)
 4. [NewBasis.](#)
 5. [Oldcastle Precast Group.](#)

6. [Riverton Concrete Products; a division of Cretex Companies, Inc.](#)
 7. [Strongwell Corporation; Lenoir City Division.](#)
 8. [Underground Devices, Inc.](#)
 9. [Utility Concrete Products, LLC.](#)
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, **26 inches (660 mm)**.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than **2.0 cu. ft. (60 L)** where packaged mix complying with ASTM C 387, Type M, may be used.
- C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, **2-inch- (50-mm-)** diameter eye, and **1-by-4-inch (25-by-100-mm)** bolt.
1. Working Load Embedded in **6-Inch (150-mm), 4000-psi (27.6-MPa)** Concrete: **13,000-lbf (58-kN)** minimum tension.
- E. Pulling-In and Lifting Irons in Concrete Floors: **7/8-inch- (22-mm-)** diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: **40,000-lbf (180-kN)** shear and **60,000-lbf (270-kN)** tension.
- F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; **1/2-inch (13-mm)** ID by **2-3/4 inches (69 mm)** deep, flared to **1-1/4 inches (32 mm)** minimum at base.
1. Tested Ultimate Pullout Strength: **12,000 lbf (53 kN)** minimum.

- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
- H. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
 2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- I. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
- J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- K. Fixed Manhole Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- L. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by a independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with utility company specifications and requirements for ducts, raceways, and enclosures for use by utility companies.

3.2 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC for normal feeders and EPC-80-PVC for emergency feeders, in direct-buried duct bank where not under paved driveways or roadways, unless otherwise indicated. Duct banks shall be concrete encased where installed under paved driveways or roadways.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths, Walks, Driveways, and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
- B. Manholes: Precast or cast-in-place concrete.
 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Provided by Division 31 in accordance with Division 31 requirements, but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32.
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01.

3.5 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured standard radius bends unless otherwise indicated and unless long-radius bends are required by utility company.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
7. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
8. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Division 31.
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31.
6. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
7. Set elevation of bottom of duct bank below the frost line.
8. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least **15 inches (380 mm)** below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch (25 mm)** above finished grade.
3. Install handholes with bottom below the frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inches (98 mm)** for manholes and **2 inches (50 mm)** for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1/2-inch (12.7-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: **3000 psi (20 kPa)**, 28-day strength, complying with Division 03, with a troweled finish.
 - 2. Dimensions: **10 inches wide by 12 inches deep (250 mm wide by 300 mm deep)**.

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than **50 inches (1270 mm)** and with no side larger than **16 inches (400 mm)**, thickness shall be **0.052 inch (1.3 mm)**.

- b. For sleeve cross-section rectangle perimeter **50 inches (1270 mm)** or more and one or more sides larger than **16 inches (400 mm)**, thickness shall be **0.138 inch (3.5 mm)**.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 1. 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. [Advance Products & Systems, Inc.](#)
 - b. [CALPICO, Inc.](#)
 - c. [Metraflex Company \(The\).](#)
 - d. [Pipeline Seal and Insulator, Inc.](#)
 - e. [Proco Products, Inc.](#)
 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 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. [Presealed Systems.](#)

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: **5000-psi (34.5-MPa)**, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Cables Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Cables Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for **1-inch (25-mm)** annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- F. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Spring isolators.
 - 3. Restrained spring isolators.
 - 4. Channel support systems.
 - 5. Restraint cables.
 - 6. Hanger rod stiffeners.
 - 7. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Section 26 05 29 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

- A. Manufacturer of seismic control equipment shall have the following responsibilities:
 - 1. Determine seismic restraint sizes and locations.
 - 2. Provide seismic restraints as scheduled or specified.
 - 3. Provide calculations and materials if required for restraint of un-isolated equipment.
 - 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
- B. Seismic restraints shall be designed in accordance with seismic force levels as detailed herein.
- C. Applicable Code: IBC
- D. Seismic Design Category C

- E. Design Spectral Response at Short Periods (SDS): See structural plans.
- F. Short Period Spectral Response Acceleration (SS): See structural plans.
- G. Building Use Group or Occupancy Category II
- H. Equipment Schedule: The following list indicates individual equipment importance factors, $I_p=1.5$:
 - 1. Fire alarm System.
 - 2. Emergency generator and emergency power distribution and wiring systems.
- I.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.
 - 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 - 3. Field-fabricated supports.

4. Seismic-Restraint Details:

- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
- c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For professional engineer.
- C. Welding certificates.
- D. Field quality-control test reports.

1.7 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. 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. [Ace Mountings Co., Inc.](#)
 2. [Amber/Booth Company, Inc.](#)
 3. [California Dynamics Corporation.](#)
 4. [Isolation Technology, Inc.](#)
 5. [Kinetics Noise Control.](#)
 6. [Mason Industries.](#)
 7. [Vibration Eliminator Co., Inc.](#)
 8. [Vibration Isolation.](#)
 9. [Vibration Mountings & Controls, Inc.](#)
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene, rubber, or hermetically sealed compressed fiberglass.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to **1/4-inch- (6-mm-)** thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to **500 psig (3447 kPa)**.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to **1/4-inch- (6-mm-)** thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. 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. [Amber/Booth Company, Inc.](#)
 2. [California Dynamics Corporation.](#)
 3. [Cooper B-Line, Inc.; a division of Cooper Industries.](#)
 4. [Hilti Inc.](#)
 5. [Loos & Co.; Seismic Earthquake Division.](#)
 6. [Mason Industries.](#)
 7. [TOLCO Incorporated; a brand of NIBCO INC.](#)
 8. [Unistrut; Tyco International, Ltd.](#)
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive.

Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment where specified in other Division 26 sections.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

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

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for conductors.
 - 2. Underground-line warning tape.
 - 3. Warning labels and signs.
 - 4. Equipment identification labels.
 - 5. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.

- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than **3 mils (0.08 mm)** thick by **1 to 2 inches (25 to 50 mm)** wide.
- B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, **3-mil- (0.08-mm-)** thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Write-On Tags: Polyester tag, **0.015 inch (0.38 mm)** thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.

2.2 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 4. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 5. Thickness: **4 mils (0.1 mm)**.
 - 6. Weight: **18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m)**.
 - 7. **3-Inch (75-mm)** Tensile According to ASTM D 882: **30 lbf (133.4 N)**, and **2500 psi (17.2 MPa)**.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: **ELECTRIC LINE, HIGH VOLTAGE,**.
 - 3. Inscriptions for Orange-Colored Tapes: **TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,**.

2.3 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. **1/4-inch (6.4-mm)** grommets in corners for mounting.
 - 3. Nominal size, **7 by 10 inches (180 by 250 mm)**.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with **0.0396-inch (1-mm)** galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. **1/4-inch (6.4-mm)** grommets in corners for mounting.
 - 3. Nominal size, **10 by 14 inches (250 by 360 mm)**.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD."

2.4 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum **1/16 inch (1.6 mm)** thick for signs up to **20 sq. inches (129 sq. cm)** and **1/8 inch (3.2 mm)** thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be **3/8 inch (10 mm)**.
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be **3/8 inch (10 mm)**. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be **3/8 inch (10 mm)**.
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be **3/8 inch (10 mm)**.

2.6 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: **3/16 inch (5 mm)**.
 - 2. Tensile Strength at **73 deg F (23 deg C)**, According to ASTM D 638: **12,000 psi (82.7 MPa)**.
 - 3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
 - 4. Color: Black except where used for color-coding.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at **6 to 8 inches (150 to 200 mm)** below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds **16 inches (400 mm)** overall.

3.2 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of **6 inches (150 mm)** from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- B. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, self-adhesive, self-laminating polyester labels with the conductor or cable designation, origin, and destination.
- E. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive, self-laminating polyester labels with the conductor designation.
- F. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - e. Enclosed switches.
 - f. Enclosed circuit breakers.
 - g. Enclosed controllers.

END OF SECTION 26 05 53

SECTION 26 05 72 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

- A. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - 1. Short-circuit study input data, including completed computer program input data sheets.
 - 2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
 - b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Short-Circuit Study Specialist
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
 - 1. ESA Inc
 - 2. Operation Technology, Inc.
 - 3. Power Analytics, Corporation.
 - 4. SKM Systems Analysis, Inc.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- G. Short-Circuit Study Output:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.

- d. No AC Decrement (NACD) ratio.
- e. Equivalent impedance.
- f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Obtain all data necessary for the conduct of the study.
 1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
- B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Obtain electrical power utility impedance at the service.
 3. Power sources and ties.
 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 9. Motor horsepower and NEMA MG 1 code letter designation.
 10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.

- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Incoming switchgear.
 - 3. Unit substation primary and secondary terminals.
 - 4. Low-voltage switchgear.
 - 5. Motor-control centers.
 - 6. Control panels.
 - 7. Standby generators and automatic transfer switches.
 - 8. Branch circuit panelboards.
 - 9. Disconnect switches.

3.3 ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

- A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION 26 05 72

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and equipment evaluation reports.
 - 3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in

equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Software Developer Coordination Study Specialist.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - b. Power system data.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:
1. ESA Inc.
 2. Operation Technology, Inc.
 3. Power Analytics, Corporation.
 4. SKM Systems Analysis, Inc.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study – Refer to Section 26 05 72 – “Overcurrent Protective Device Short-Circuit Study”.

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - e. Cables and conductors damage curves.
 - f. Ground-fault protective devices.
 - g. Motor-starting characteristics and motor damage points.
 - h. Generator short-circuit decrement curve and generator damage point.
 - i. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Provide adequate time margins between device characteristics such that selective operation is achieved.

6. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 10 kA or less.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Motor Protection:
 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- I. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

- J. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- K. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Low-voltage Switchboards.
 - 3. Standby generators and automatic transfer switches.
 - 4. Branch circuit panelboards.
- L. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 - 3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
 - 1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 241 and IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Electrical power utility impedance at the service.
 - 3. Power sources and ties.

4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Voltage level at each bus.
6. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
7. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
8. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
11. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
12. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.
 - k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.4 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.5 DEMONSTRATION

- A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:
 1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
 2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
 3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 26 05 73

SECTION 26 09 23-LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Photoelectric switches.
 - 2. Indoor occupancy sensors.
 - 3. Lighting contactors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Cooper Industries, Inc.](#)

2. [Intermatic, Inc.](#)
3. [NSi Industries LLC; TORK Products.](#)
4. [Tyco Electronics; ALR Brand.](#)

B. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: **1.5 to 10 fc (16.14 to 108 lux)**, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Lightning Arrester: Air-gap type.

2.2 INDOOR OCCUPANCY SENSORS

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

1. [Bryant Electric; a Hubbell company.](#)
2. [Cooper Industries, Inc.](#)
3. [Hubbell Building Automation, Inc.](#)
4. [Leviton Mfg. Company Inc.](#)
5. [Lithonia Lighting; Acuity Lighting Group, Inc.](#)
6. [Lutron Electronics Co., Inc.](#)
7. [Sensor Switch, Inc.](#)
8. [Square D; a brand of Schneider Electric.](#)

B. General Requirements for Sensors: Ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a **1/2-inch (13-mm)** knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell H-MOSS or comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Leviton Mfg. Company Inc.
 3. Lightolier Controls.
 4. Sensor Switch, Inc.
 5. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[,
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag OS:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 1000 sq. ft. (84 sq. m).
 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
 4. Voltage: Match the circuit voltage type.
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

D. Wall-Switch Sensor Tag OS2:

1. Standard Range: 180-degree field of view, with a minimum coverage area of 1000 sq. ft. (84 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, dual circuit, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Match the circuit voltage; type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 LIGHTING CONTACTORS

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

1. [Allen-Bradley/Rockwell Automation.](#)
2. [ASCO Power Technologies, LP; a division of Emerson Electric Co.](#)
3. [Eaton Corporation.](#)
4. [General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.](#)
5. [Square D; a brand of Schneider Electric.](#)

B. Description: Electrically operated and mechanically held, combination-type lighting contactors complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
5. Where two-wire maintained switch control is indicated, provide solid-state control modules as required for indicated switching arrangement.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is **1/2 inch (13 mm)**.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.6 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 26 09 43 "Network Lighting Controls."
- B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes manually operated lighting controls with relays, time clock, photocell control, external source relays and control module.
- B. Related Sections:
 - 1. Section 26 09 23 "Lighting Control Devices" for photoelectric sensors, occupancy sensors, and multipole contactors.

1.3 MANDATORY PROGRAMMING MEETING

- 1.4 Lighting control system programming shall be mapped out at a meeting between the owner, engineer, and contractor. This meeting shall be scheduled by the Contractor and shall be completed before product is ordered. Action Submittals for this section shall not be returned to the Contractor before this meeting is completed.

1.5 DEFINITIONS

- A. BACnet: A networking communication protocol that complies with ASHRAE 135.
- B. BAS: Building automation system.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- F. PC: Personal computer; sometimes plural as "PCs."

- G. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
- H. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.
- I. UTP: Unshielded twisted pair.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- B. Field quality-control reports.
- C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- D. Warranty: Sample of special warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.9 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with NFPA 70.

1.10 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.
- B. Coordinate lighting control components specified in this Section with components specified in Section 26 24 16 "Panelboards."

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 - 2. Warranty Period: Two years from date of Substantial Completion.

3. Extended Warranty Period Failure Due to Transient Voltage Surges: five years.
4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.12 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.
 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide Hubbell LX series or comparable product by one of the following:
 1. Acuity Brands Lighting, Inc.; Lithonia Lighting brand.
 2. Cooper Controls
 3. Leviton Mfg. Company Inc.
 4. Lighting Control & Design, Inc.
 5. Lightolier Controls; a division of Genlyte Group, LLC.
 6. Lutron Electronics Co., Inc.
 7. Wattstopper, project-specific custom solution.

2.2 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

2.3 CONTROL MODULE

- A. Control Module Description: Comply with UL 508 (CAN/CSA C22.2, No. 14); microprocessor-based, networked, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.

2.4 POWER DISTRIBUTION COMPONENTS

- A. Modular Relay Panel: Comply with UL 508, UL 916, and UL 924; factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
1. Cabinet: Steel with hinged, locking door.
 - a. Barriers separate low-voltage and line-voltage components.
 - b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
 - c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
 2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
 - a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
 - b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
 - c. Endurance: 50,000 cycles at rated capacity.
 - d. Mounting: Provision for easy removal and installation in relay cabinet.
- B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels or field-mounting surge suppressors that comply with Section 26 43 13 "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for Category A locations.

2.5 MANUAL ANALOG SWITCHES AND PLATES

- A. Push-Button or key-operated type switches as indicated on the drawings: Modular, momentary-contact, low-voltage type.
1. Match color specified in Section 26 27 26 "Wiring Devices."
 2. Integral green LED pilot light to indicate when circuit is on.
 3. Where key operated switches are indicated, the Owner shall have the option of choosing, at the mandatory programming meeting, push-button switches that are programmed to be inoperative during school hours.

- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 26 27 26 "Wiring Devices."
- C. Wall Plates: Single and multigang plates as specified in Section 26 27 26 "Wiring Devices."
- D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

- A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.
- B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
 - 1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Section 26 27 26 "Wiring Devices."
 - 2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Section 26 74 00 "Telecommunications."
- E. RS-485 Cables:
 - 1. Standard Cable: NFPA 70, Type CMR.
 - a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1581.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Minimum conduit size shall be **1/2 inch (13 mm)**.
 - 1. For power wiring comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Section 26 05 23 "Control-Voltage Electrical Power Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- G. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Test for circuit continuity.
 - 2. Verify that the control module features are operational.
 - 3. Check operation of local override controls.
 - 4. Test system diagnostics by simulating improper operation of several components selected by Architect.
- C. Lighting controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.3 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.4 ADJUSTING

- A. 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.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. See Division 01 for further information.

END OF SECTION 26 09 43

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Transient voltage suppression devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Accessory components and features.
 - 6. Identification.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field Quality-Control Reports:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 1. Routine maintenance requirements for switchboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).

- B. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding **6600 feet (2000 m)**.

- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.

- B. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections rear aligned.
- C. Nominal System Voltage: 208Y/120 V.
- D. Main-Bus Continuous: 4000 A.
- E. Short-circuit interrupting (AIC) rating: Fully rated for available fault current at installed location as determined by overcurrent protective device short-circuit current study, but not less than 100,000 A, symmetrical.
- F. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- G. Indoor Enclosures: Steel, NEMA 250, Type 1.
- H. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- I. Barriers: Between adjacent switchboard sections.
- J. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- K. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- L. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- N. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
 - 2. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from branch end.

4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 5. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules), with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Integral disconnect switch.
 3. Redundant suppression circuits.
 4. Redundant replaceable modules.
 5. LED indicator lights for power and protection status.
 6. Audible alarm, with silencing switch, to indicate when protection has failed.
 7. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 8. Six-digit, transient-event counter set to totalize transient surges.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
- C. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- D. Protection modes and UL 1449 SVR for grounded wye circuits with 208/Y120-V, three-phase, four-wire circuits shall be as follows:
1. Line to Neutral: 400 V for 208/Y120.
 2. Line to Ground: 400 V for 208/Y120.
 3. Neutral to Ground: 400 V for 208/Y120.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Selective Coordination: Provide overcurrent protective devices that selective coordinate with downstream devices in accordance with code requirements.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.4 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

- d. Kilowatts: Plus or minus 2 percent.
 - e. Kilovars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Kilowatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Kilowatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.7 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, **4-inch (100-mm)** nominal thickness. Comply with requirements for concrete base specified in Division 03.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Switchboard will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.16 "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding **minus 22 deg F (minus 30 deg C)** to **plus 104 deg F (plus 40 deg C)**.
 - b. Altitude: Not exceeding **6600 feet (2000 m)**.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding **6600 feet (2000 m)**.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
 - 3. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets as indicated on the drawings.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel or Same finish as panels and trim.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder
- C. Incoming Mains Location: Top or bottom to match feeder locations.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- I. Selective Coordination: Provide overcurrent protective devices that selective coordinate in accordance with code requirements.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 3. [Siemens Energy & Automation, Inc.](#)
 4. [Square D; a brand of Schneider Electric.](#)
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than **36 inches (914 mm)** high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only as scheduled.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 - 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 - 3. [Siemens Energy & Automation, Inc.](#)
 - 4. [Square D; a brand of Schneider Electric.](#)
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only as scheduled.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.5 LOAD CENTERS – Use in dwelling units.

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton.
 - 2. General Electric Company; GE Energy Management - Electrical Distribution.
 - 3. Siemens Energy.
 - 4. Square D; a brand of Schneider Electric
- B. Load Centers: Comply with UL 67.
- C. Mains: Circuit breaker or lugs as scheduled.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 3. [Siemens Energy & Automation, Inc.](#)
 4. [Square D; a brand of Schneider Electric.](#)
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at percent of rated voltage.
 - e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - f. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - g. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - h. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Mount top of trim **90 inches (2286 mm)** above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four **1-inch (27-GRC)** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four **1-inch (27-GRC)** empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Panelboards will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 26 24 16

SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes equipment for electricity metering by utility company.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Dimensioned plans and sections or elevation layouts.

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.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.6 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 - 1. Comply with requirements of utilities providing electrical power services.

2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Meter Sockets: Comply with requirements of electrical-power utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
 1. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

END OF SECTION 26 27 13

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Weather-resistant receptacles.
 - 4. Snap switches and wall-box dimmers.
 - 5. Pendant cord-connector devices.
 - 6. Cord and plug sets.
 - 7. Poke-through assemblies and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 2. Hubbell Incorporated; Wiring Device-Kellems.
 3. Leviton Manufacturing Co., Inc.
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, non-feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A, NEMA 5-20R.

2.5 TWIST-LOCKING RECEPTACLES

- A. Comply with NEMA WD 1, NEMA WD 6 configurations as indicated on the drawings, and UL 498.

2.6 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
 - 1. Matching, locking-type plug and receptacle body connector.
 - 2. NEMA WD 6 Configurations as indicated on the drawings, heavy-duty grade, and FS W-C-596.
 - 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
 - 4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

- A. Description:
 - 1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
 - 3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Single Pole:
 - 2. Two Pole:
 - 3. Three Way:
 - 4. Four Way:
- C. Pilot-Light Switches, 20 A:
 - 1. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."
- D. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.9 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Fluorescent Lamp and LED Dimmer Switches: Modular; compatible with dimmer ballasts or LED drivers; trim potentiometer to adjust low-end dimming; dimmer-ballast or dimmer-driver combination capable of consistent dimming with low end not greater than 5 percent of full brightness.

2.10 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: ~~0.035-inch-~~ (1-mm-) thick, satin-finished, Type 302 stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.
- C. Plates shall be Factory engraved "GENERATOR" for receptacles connected to generator-connected panels.

2.11 POKE-THROUGH ASSEMBLIES

A. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Flush type with services indicated and complying with requirements in Section 27 15 00 "Communications Horizontal Cabling" where communications outlets are indicated.
4. Size: Selected to fit nominal **3-inch (75-mm)** or **4-inch (100-mm)** cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused **3-inch (75-mm)** or **4-inch (100-mm)** cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 27 15 00 "Communications Horizontal Cabling."

2.12 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Description:

1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

B. Raceway Material: Metal, with manufacturer's standard finish.

C. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: **6 inches (150 mm)**.
3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit or multiple circuits as indicated.

2.13 FINISHES

A. Device Color:

1. Wiring Devices: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install device boxes so that the cover plate does not cross a joint in wall finish materials unless the joint is troweled flush with the face of the wall.
 - 5. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than **6 inches (152 mm)** in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
 - 1. Install dimmers within terms of their listing.
 - 2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

- 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
- 3. Current-limitation curves for fuses with current-limiting characteristics.
- 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
- 5. Coordination charts and tables and related data.
- 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified Division 01, include the following:

- 1. Ambient temperature adjustment information.
- 2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders: Class RK1, time delay or Class RK5, time delay.
 - 2. Motor Branch Circuits: Class RK5, time delay.
 - 3. Other Branch Circuits: Class RK1, time delay or Class RK5, time delay.
 - 4. Control Circuits: Class CC, time delay.
- B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.

3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than **minus 22 deg F (minus 30 deg C)** and not exceeding **104 deg F (40 deg C)**.
 - 2. Altitude: Not exceeding **6600 feet (2010 m)**.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 - 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 - 3. [Siemens Energy & Automation, Inc.](#)
 - 4. [Square D; a brand of Schneider Electric.](#)
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac as appropriate for circuit voltage, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to

accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
3. [Siemens Energy & Automation, Inc.](#)
4. [Square D; a brand of Schneider Electric.](#)

B. Type HD, Heavy Duty, Single Throw,-240 or 600-V ac as appropriate for circuit voltage, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

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

1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
3. [Siemens Energy & Automation, Inc.](#)
4. [Square D; a brand of Schneider Electric.](#)

- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I^2t response.
- D. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- F. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- G. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 8. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.4 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 - 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 - 3. [Siemens Energy & Automation, Inc.](#)
 - 4. [Square D; a brand of Schneider Electric.](#)

- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 26 28 16

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Nameplate legends.
 - d. Short-circuit current rating of integrated unit.
 - e. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.
- C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.

1.8 QUALITY ASSURANCE

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

- B. Comply with NFPA 70.
- C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than **minus 22 deg F (minus 30 deg C)** and not exceeding **104 deg F (40 deg C)**.
 - 2. Altitude: Not exceeding **6600 feet (2010 m)**.
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of electrical systems.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with interruption of electrical systems without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 - b. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 - c. [Rockwell Automation, Inc.; Allen-Bradley brand.](#)
 - d. [Siemens Energy & Automation, Inc.](#)
 - e. [Square D; a brand of Schneider Electric.](#)
 2. Configuration: Nonreversing.
 3. Surface mounting.
 4. Red pilot light.
- C. Magnetic Controllers: Full voltage, across the line, electrically held.
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. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 - b. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 - c. [Rockwell Automation, Inc.; Allen-Bradley brand.](#)
 - d. [Siemens Energy & Automation, Inc.](#)
 - e. [Square D; a brand of Schneider Electric.](#)
 2. Configuration: Nonreversing
 3. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 5. Control Circuits: 120-V ac maximum; obtained from integral CPT, with primary and secondary fuses, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
 6. Melting Alloy Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 7. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.

- c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
8. Solid-State Overload Relay:
- a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
9. N.O., isolated overload alarm contact.
10. External overload reset push button.
- D. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
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. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 - b. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 - c. [Rockwell Automation, Inc.; Allen-Bradley brand.](#)
 - d. [Siemens Energy & Automation, Inc.](#)
 - e. [Square D; a brand of Schneider Electric.](#)
 2. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 3. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
 4. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.O. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

5. MCCB Disconnecting Means:

- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
- b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
- e. N.O. alarm contact that operates only when MCCB has tripped.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1.
 2. Outdoor Locations: Type 3R
 3. Other Wet or Damp Indoor Locations: Type 4X.

2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, type.
 - a. Push Buttons: Recessed types; momentary.
 - b. Pilot Lights: LED types; colors as indicated; push to test.
 - c. Selector Switches: Rotary type Hand-off-automatic for units with remote automatic control; on-off for units with only local control.
- B. Reversible N.C./N.O. auxiliary contact(s).
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- D. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems."
- B. Seismic Bracing: Comply with requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 28 13 "Fuses."
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.
- D. Set field-adjustable circuit-breaker trip ranges.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers

END OF SECTION 26 29 13

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Gas engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Performance requirements for sensitive loads.
 - 5. Load banks.
 - 6. Outdoor enclosure.
- B. Related Sections include the following:
 - 1. Section 26 36 00 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. LP: Liquid petroleum.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that LP day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Section 26 05 48.16 "Seismic Controls for Electrical Systems." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For installer and manufacturer.
- C. Source quality-control test reports.
 1. Certified summary of prototype-unit test report.
 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 4. Report of sound generation.
 5. Report of exhaust emissions showing compliance with applicable regulations.
 6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- D. Field quality-control test reports.
- E. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- 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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
 - 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- J. Comply with UL 2200.

- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries, but not more than 71 dB(A) @ 23' under full load due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation. In a
- M. PROJECT CONDITIONS
- N. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- O. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: Minus 15 to plus 40 deg C.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 1000 feet (300 m).
- P. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:

1.9 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: five years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for

proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

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:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide equipment and services as manufactured by Caterpillar, Inc. or a comparable product by one of the following:
 - 1. Kohler Co.; Generator Division.
 - 2. Onan/Cummins Power Generation; Industrial Business Group.
- D. ENGINE-GENERATOR SET
- E. Factory-assembled and -tested, engine-generator set.
- F. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- G. Capacities and Characteristics:
 - 1. Power Output Ratings: 250kW at 0.8 power factor. 312.5 kVA
 - 2. Output Connections: 208/120-volts three-phase, four wire.
 - 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- H. Generator-Set Performance:
 - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

I. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.2 ENGINE

- A. Fuel: Natural gas with automatic LP-gas standby.
 - 1. The work of this section includes providing fuel as required for startup, testing, commissioning, and training activities plus topping off the LP fuel tank so that it is full upon acceptance by the Owner.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: The following items are mounted on engine or skid:
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
 - 1. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:
 - a. Carburetor.
 - b. Secondary Gas Regulators: One for each fuel type.
 - c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
 - d. Flexible Fuel Connectors: One for each fuel source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 1. Minimum sound attenuation of 25 dB at 500 Hz.
 2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

- K. Starting System: 24-V electric, with negative ground.
 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
 5. Battery Cable: Size as recommended by engine manufacturer for cable length. Include required interconnecting conductors and connection accessories.
 6. Battery Rack: Factory fabricated of metal with acid-resistant finish. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Mounting: Within generator enclosure.

2.3 LP-GAS STORAGE

A. Comply with NFPA 58.

1. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine-generator system without being refilled.
2. Low-Level Alarm Sensor: Device operates alarm contacts at 25 percent of normal fuel level.
3. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

2.4 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.

8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

E. Indicating and Protective Devices and Controls:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Generator overload.

F. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

G. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Section 26 09 13 "Electrical Power Monitoring and Control."

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Generator Disconnect Switch: Molded-case type, 100 percent rated.
1. Rating: Matched to generator output rating.
 2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.
- C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip-proof.
- G. Instrument Transformers: Mounted within generator enclosure.

- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. The complete diesel engine generator set, including generator control panel, engine starting batteries and battery charger, shall be enclosed in a factory assembled, sound attenuated enclosure.
 - 1. A weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of 71.0 dB(A) @ 23 ft with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.
 - 2. Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.
- C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
 - 1. DC lighting system for operation when remote source and generator are both unavailable.
- D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.8 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolation Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.9 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Full load run.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Transient and steady-state governing.
 - 6. Single-step load pickup.
 - 7. Safety shutdown.
 - 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 - 9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator on cast-in-place concrete equipment bases. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 26 05 29, "Hangers and Supports for Electrical Systems."

1. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
 2. Comply with requirements for vibration isolation devices specified in this section.
- D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Connect fuel piping to engines with a gate valve and union and flexible connector.
1. Natural-gas and LP-gas piping, valves, and specialties for gas distribution and piping are specified in Division 23.
- E. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify system components according to Section 23 05 53 "Identification for HVAC Piping and Equipment" and Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 3. The manufacturer's local dealer shall provide a temporary resistive 1.0 PF load bank and temporary cable to test the generator set at 100% nameplate rating. All fuel for testing is to be supplied by the contractor.

4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus

connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01.

END OF SECTION 26 32 13

SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
 - 2. Manual transfer switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
 1. Features and operating sequences, both automatic and manual.
 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 110.
- G. Comply with NFPA 99.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.7 COORDINATION

- A. For floor mounted equipment, coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Contactor Transfer Switches:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Emerson; ASCO Power Technologies, LP Series 3000 or comparable product by one of the following:
 - a. Kohler Power Systems; Generator Division.
 - b. Onan/Cummins Power Generation; Industrial Business Group.
 - c. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

- H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 26 05 53 "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- I. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- G. Automatic Transfer-Switch Features:
 - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- C. Identify components according to Section 26 05 53 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.

- b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- B. Coordinate tests with tests of generator and run them concurrently.
 - C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - D. Remove and replace malfunctioning units and retest as specified above.
 - E. Prepare test and inspection reports.
 - F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as in Division 01.
- B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

SECTION 26 51 16 - FLUORESCENT INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Interior fluorescent luminaires, lamps, and ballasts.
- 2. Luminaire supports.

- B. Related Requirements:

- 1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- 2. Section 26 09 43 "Network Lighting Controls for lighting control panels.

1.3 DEFINITIONS

- A. BIM: Building information model.
- B. CAD: Computer-aided design.
- C. CCT: Correlated color temperature.
- D. CRI: Color Rendering Index.
- E. Fixture: See "Luminaire."
- F. IP: International Protection or Ingress Protection Rating
- G. Lumen: Measured output of lamp and luminaire, or both.
- H. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.
4. Ballast, including BF.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Include photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Photometric data shall be certified by a qualified independent testing agency or by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples for Verification: As requested by Architect.

1. Include Samples of luminaires and accessories to verify finish selection.
2. Lamps and ballasts, installed.
3. Cords and plugs.
4. Pendant support system.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within **12 inches (300 mm)** of the plane of the luminaires.
4. Structural members to which equipment and/or luminaires will be attached.
5. Initial access modules for acoustical tile.
6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling mounted projectors.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled luminaires, from manufacturer.
- D. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- E. Sample warranty.
- F. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- G. Copies of Efficiency Maine rebate pre-approval applications.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

- C. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. UL Compliance: Comply with UL 1598.
- D. Lamp base complying with ANSI C81.61.

- E. Nominal Operating Voltage: As scheduled on drawings.
- F. Recessed Luminaires: Comply with NEMA LE 4.
- G. EMI Filters: Factory installed to suppress conducted EMI according to MIL-STD-461E. Fabricate luminaires with one filter on each ballast indicated to require a filter.
- H. Refer to Luminaire Schedule on Drawings for further information.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
 - 1. Comply with UL 935 and with ANSI C82.11.
 - 2. Designed for type and quantity of lamps served.
 - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
 - 4. Sound Rating: Class A.
 - 5. THD Rating: Less than 10 percent.
 - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 7. Operating Frequency: 42 kHz or higher.
 - 8. Lamp Current Crest Factor: 1.7 or less.
 - 9. BF: 0.88 or higher.
 - 10. Power Factor: 0.98 or higher.
 - 11. Parallel Lamp Circuits: For luminaires connected to emergency system, multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
- C. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
 - 1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 - 2. Automatic lamp starting after lamp replacement.
- D. Ballasts for Low-Temperature Environments:
 - 1. Temperatures **0 Deg F (Minus 17 Deg C)** and Higher: Electronic type rated for **0 deg F (minus 17 deg C)** starting and operating temperature with indicated lamp types.
 - 2. Temperatures **Minus 20 Deg F (Minus 29 Deg C)** and Higher: Electromagnetic type designed for use with indicated lamp types.
- E. Ballasts for Low-EMI Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on EMI and RFI for consumer equipment.

- F. Ballasts for Bi-Level Controlled Luminaires: Electronic type. Provide where step dimming control is indicated on the drawings.
1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level operation and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
 2. Ballast shall provide equal current to each lamp in each operating mode.
 3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. THD Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher unless otherwise indicated.
 9. Power Factor: 0.98 or higher.
 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on EMI and RFI for nonconsumer equipment.

2.5 FLUORESCENT LAMPS

- A. T5 rapid-start lamps, rated 28-W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI of 85 (minimum), color temperature as scheduled on the drawings, and average rated life of 20,000 hours unless otherwise indicated.
- B. T5HO rapid-start, high-output lamps, rated 54-W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI of 85 (minimum), color temperature as scheduled on the drawings, and average rated life of 20,000 hours unless otherwise indicated.
- C. Compact Fluorescent Lamps: Four-pin, CRI of 80 (minimum), color temperature as scheduled on the drawings, and average rated life of 10,000 hours at three hours of operation per start unless otherwise indicated.
1. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 2. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 3. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

2.6 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Glass: Annealed crystal glass unless otherwise indicated.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least **0.125 inch (3.175 mm)** minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.7 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.8 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Stem Hangers: **1/2-inch (13-mm)** steel tubing with swivel ball fittings and ceiling canopy. Finish shall match luminaire.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, **12 gage (2.68 mm)** minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- D. Install lamps in each luminaire.
- E. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them.
- F. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- G. Ceiling-Grid-Mounted Luminaire Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than **6 inches (150 mm)** from luminaire corners.

2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two **3/4-inch (20-mm)** metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on luminaire. Wire or rod shall have breaking strength of the luminaire weight at a safety factor of 3.

H. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

I. Wall-Mounted Luminaire Support methods:

1. Attached to structural members in walls
2. Attached to a minimum 20 gauge backing plate attached to wall structural members
3. Attached using through bolts and backing plates on either side of wall.
4. Do not attach luminaires directly to gypsum board.

J. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than **48 inches (1200 mm)**, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or cord for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

- K. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
- B. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 1. Test for Emergency Lighting: Interrupt normal power supply to demonstrate proper operation. Verify transfer from normal power to emergency power and retransfer to normal.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 16

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Interior solid-state luminaires that use LED technology.
- 2. Lighting fixture supports.

- B. Related Requirements:

- 1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- 2. Section 26 09 43 "Network Lighting Controls for lighting control panels.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include life, output (lumens, CCT, and CRI), and energy efficiency data.

5. Photometric data and adjustment factors based on laboratory tests IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
 1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Samples for Verification: As requested by Architect.
 1. Include Samples of luminaires and accessories to verify finish selection.
- D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Lighting luminaires.
 2. Suspended ceiling components.
 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
 4. Structural members to which equipment and/or luminaires will be attached.
 5. Initial access modules for acoustical tile, including size and locations.
 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Certificates: For luminaires, 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.
- D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of luminaire.
- F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- G. Sample warranty.
- H. Copies of Efficiency Maine rebate pre-approval applications.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp module types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamp modules: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

- E. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. Recessed Fixtures: Comply with NEMA LE 4.
- D. CRI of minimum 70. CCT as scheduled on the drawings.
- E. Rated lamp life of 50,000 hours.

- F. Lamps dimmable from 100 percent to 0 percent of maximum light output where dimming control is indicated on the drawings.
- G. Internal driver or remote driver as applicable for each scheduled luminaire.
- H. Nominal Operating Voltage: As scheduled on the drawings. .
 - 1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 - 1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Stem Hangers: **1/2-inch (13-mm)** steel tubing with swivel ball fittings and ceiling canopy. Finish shall match luminaire.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, **12 gage (2.68 mm)** minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Ceiling-Grid-Mounted Luminaire Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than **6 inches (150 mm)** from luminaire corners.
 - 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.

3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two **3/4-inch (20-mm)** metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on luminaire. Wire or rod shall have breaking strength of the luminaire weight at a safety factor of 3.

F. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

G. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls
2. Attached to a minimum 20 gauge backing plate attached to wall structural members
3. Attached using through bolts and backing plates on either side of wall.
4. Do not attach luminaires directly to gypsum board.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than **48 inches (1200 mm)**, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or cord for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

- I. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt normal power supply to demonstrate proper operation. Verify transfer from normal power to emergency power and retransfer to normal.

- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 26 09 43 "Network Lighting Controls."

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 19

SECTION 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire alarm wire and cable.
 - 2. Identification products.

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- B. Open Cabling: Passing cabling through open space (e.g., between the studs of a wall cavity).

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

1.6 FIELD CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
 - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Comtran Corporation](#).
 - 2. [Draka Cableteq USA](#).
 - 3. [Genesis Cable Products; Honeywell International, Inc.](#)
 - 4. [Rockbestos-Suprenant Cable Corp.](#)
 - 5. [West Penn Wire](#).
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer, but not smaller than 18 AWG.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.3 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. [Brady Worldwide, Inc.](#)
 - 2. [Kroy LLC](#).
 - 3. [Panduit Corp.](#)
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

- A. Install wiring in metal raceways.
 - 1. Minimum conduit size shall be **1/2 inch**. Control and data transmission wiring shall not share conduit with other building wiring systems.
 - 2. Comply with requirements in Division 26.
- B. Install raceways concealed in accessible ceilings, walls, and floors.

3.3 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- E. For Class A circuits, provide separate conduits or cable for outgoing and return conductors.
- F. Wiring to Remote Alarm Transmitting Device: **1-inch (25-mm)** conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

- A. Comply with requirements in Section 28 31 11 "Digital, Addressable Fire-Alarm System for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

- A. Comply with requirements in Division 07.

3.7 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and labeling of all components.

END OF SECTION 28 05 13

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Firefighters' two-way telephone communication service.
8. Magnetic door holders.
9. Remote annunciator.
10. Addressable interface device.
11. Digital alarm communicator transmitter.
12. Radio alarm transmitter.
13. Network communications.
14. System printer.

- B. Related Requirements:

1. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 2. Include plans, elevations, sections, details, and attachments to other work.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 4. Detail assembly and support requirements.
 5. Include voltage drop calculations for notification-appliance circuits.
 6. Include battery-size calculations.
 7. Include input/output matrix.
 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 9. Include performance parameters and installation details for each detector.
 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
 - d. Show air-sampling detector pipe routing.
 12. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 13. For new-construction and renovated areas, include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.

- D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.6 Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.

- e. Device addresses.
 - f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
 - g. Record copy of site-specific software.
 - h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - i. Manufacturer's required maintenance related to system warranty requirements.
 - j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- B. Provide documentation required by local fire department for installation in the fire alarm Records Cabinet.
- C. Software and Firmware Operational Documentation:
- 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 2. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 3. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 4. Keys and Tools: One extra set for access to locked or tamperproofed components.
 - 5. Audible and Visual Notification Appliances: One of each type installed.
 - 6. Fuses: Two of each type installed in the system.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 and local fire department requirements.

1.10 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
 - 2. Do not proceed with interruption of fire-alarm service without Construction Manager's and Owner's written permission.
- C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.12 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: The existing system manufacturer is Notifier. The fire alarm control panel and components specified in this section shall be compatible with existing system components to remain in existing areas. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system and with existing components to remain in existing areas.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Carbon monoxide detectors.
 - 6. Combustible gas detectors.
 - 7. Automatic sprinkler system water flow.
 - 8. Preaction system.
 - 9. Fire-extinguishing system operation.
 - 10. Fire standpipe system.
 - 11. Dry system pressure flow switch.
 - 12. Fire pump running.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances, including voice evacuation notices.
 - 2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Release fire and smoke doors held open by magnetic door holders.
 - 5. Activate voice/alarm communication system.
 - 6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - 7. Activate stairwell and elevator-shaft pressurization systems.
 - 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.

9. Activate preaction or dry pipe system.
10. Recall elevators to primary or alternate recall floors.
11. Activate elevator power shunt trip.
12. Activate emergency lighting control.
13. Activate emergency shutoffs for gas and fuel supplies.
14. Record events in the system memory.
15. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Elevator shunt-trip supervision.
4. Fire pump running.
5. Fire-pump derangement.
6. Independent fire-detection and -suppression systems.
7. User disabling of zones or individual devices.
8. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.

E. System Supervisory Signal Actions:

1. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, and remote annunciators.
2. Record the event on system printer.
3. After a time delay if required by local fire department, transmit a trouble or supervisory signal to the remote alarm receiving station if required by the local fire department.
4. Transmit system status to building management system.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

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

2.4 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class A.
2. Pathway Survivability: Level 1.
3. Install no more than addressable devices on each signaling-line circuit.
4. Serial Interfaces:
 - a. One dedicated RS 485 port for remote station operation using point ID DACT.

- b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
- c. One USB port for PC configuration.
- d. One RS 232 port for voice evacuation interface.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center or as a special module that is part of fire-alarm control unit.
 - 1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
 - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
 - 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 - 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- L. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm radio transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed lead calcium.
- N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral or attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Station Reset: Key- or wrench-operated switch.
 3. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.6 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Multiple levels of detection sensitivity for each sensor.
 - d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.

- b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
- 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 - 4. Each sensor shall have multiple levels of detection sensitivity.
 - 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
- 1. Mounting: Adapter plate for outlet box mounting.
 - 2. Testable by introducing test carbon monoxide into the sensing cell.
 - 3. Detector shall provide alarm contacts and trouble contacts.
 - 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - 5. Comply with UL 2075.
 - 6. Locate, mount, and wire according to manufacturer's written instructions.
 - 7. Provide means for addressable connection to fire-alarm system.
 - 8. Test button simulates an alarm condition.

2.8 MULTICRITERIA DETECTORS

- A. Mounting: Twist-lock base interchangeable with smoke-detector bases.
- B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

- D. Test button tests all sensors in the detector.
- E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1. Primary status.
 - 2. Device type.
 - 3. Present sensitivity selected.
 - 4. Sensor range (normal, dirty, etc.).
- F. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.
 - 1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
 - 2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
 - 3. Heat sensor shall be as described in "Heat Detectors" Article.
 - 4. Each sensor shall be separately listed according to requirements for its detector type.

2.9 NONSYSTEM SMOKE DETECTORS

- A. General Requirements for Nonsystem Smoke Detectors:
 - 1. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
- B. Single-Station Smoke Detectors:
 - 1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
 - 2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A.
 - 3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
 - 4. Visible Notification Appliance: 177-cd strobe.
 - 5. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
 - 6. Test Switch: Push to test; simulates smoke at rated obscuration.
 - 7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 - 8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - 10. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

2.10 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
 - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of **135 deg F (57 deg C)** or a rate of rise that exceeds **15 deg F (8 deg C)** per minute unless otherwise indicated.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of **190 deg F (88 deg C)**.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.11 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum **1-inch- (25-mm-)** high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, white.
- C. Voice/Tone Notification Appliances:
 - 1. Comply with UL 1480.
 - 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - 3. High-Range Units: Rated 2 to 15 W.

4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Flush.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

D. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.12 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

1. Selective-talk type for use by firefighters and fire wardens.
2. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.
3. Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Module shall be capable of differentiating between normal, off-hook, and trouble conditions.
4. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it causes an audible signal to sound and a high-intensity lamp to flash at the fire command center.
5. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
6. Display: digital to indicate location of caller.
7. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
 - a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Warden Phone" or "Fire Emergency Phone."
 - b. With "break-glass" type door access lock.
8. Handsets: push-to-talk-type sets with noise-canceling microphone stored in a cabinet.

2.13 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.

2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.14 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.15 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall or to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.16 RADIO ALARM TRANSMITTER

A. Provide wireless master boxes, signal system interface panels, antennas, repeaters, and components as required by local fire department for complete and operable connection to the local Public Safety Answering Point.

2.17 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
- C. Provide integration gateway for connection to building automation system. Coordinate communications protocol with Division 23.

2.18 SYSTEM PRINTER

- A. Printer shall be listed and labeled as an integral part of fire-alarm system.

2.19 FIRE ALARM RECORDS CABINET

- A. Provide lockable wall mounted cabinet per local standards and specifications to house record documents. Locate cabinet per local fire department standards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Expand, modify, and supplement existing control equipment as necessary to provide network communications with control panel specified in this section. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Install wall-mounted equipment, with tops of cabinets not more than **78 inches (1980 mm)** above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- D. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within **60 inches (1520 mm)** of the exit doorway.
 - 2. The operable part of manual fire-alarm box shall be between **42 inches (1060 mm)** and **48 inches (1220 mm)** above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- E. Smoke- or Heat-Detector Spacing:
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed **30 feet (9 m)**.
 - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
 - 5. HVAC: Locate detectors not closer than **36 inches (910 mm)** from air-supply diffuser or return-air opening.
 - 6. Lighting Fixtures: Locate detectors not closer than **12 inches (300 mm)** from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than **36 inches (9100 mm)** long shall be supported at both ends.
 - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

- I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- K. Audible Alarm-Indicating Devices: Install not less than **6 inches (150 mm)** below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least **6 inches (150 mm)** below the ceiling. Install all devices at the same height unless otherwise indicated.
- M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

- A. Pathways shall be installed in EMT.
- B. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08. Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than **36 inches (910 mm)** from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Alarm-initiating connection to elevator recall system and components.
 - 4. Alarm-initiating connection to activate emergency lighting control.
 - 5. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 6. Supervisory connections at valve supervisory switches.
 - 7. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 8. Supervisory connections at elevator shunt-trip breaker.
 - 9. Data communication circuits for connection to building management system.
 - 10. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction where required by local standards.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

- F. Prepare test and inspection reports.
- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11

SECTION 32 14 13
PRECAST CONCRETE UNIT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-interlocking concrete paver units.
- B. Sand setting bed.
- C. Sand joint filler.
- D. Paver pedestal and shims.
- E. Edge restraints.

1.02 RELATED REQUIREMENTS

- A. Section 07 54 00 - Thermoplastic Membrane Roofing: Insulation underlayment and coverboard.

1.03 REFERENCE STANDARDS

- A. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2013.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide characteristics of paver unit, dimensions, and special shapes.
- C. Samples: Submit two samples of each paver type, illustrating style, size, color range and surface texture of units being provided.
- D. Maintenance Materials: Provide the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Pavers: 10 of each type and size.
 - 3. Upon completion provide the Owner one set of complete tools necessary for removal and installation of the complete paver system. The Contractor shall provide removal and installation procedure instructions and demonstration to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Non-interlocking Concrete Pavers:
 - 1. Basis of Design: Textured Sand Pavers by Wausau Tile Co.
 - 2. Hanover Architectural Products, Inc:
 - 3. Oldcastle:
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A. Non-interlocking Pavers: Precast concrete.
 - 1. Compressive Strength: Minimum of 7200 psi.
 - 2. Absorption: 5 percent average, with maximum of 6 percent per ASTM C140
 - 3. Air Entrainment: 5 to 7 percent.
 - 4. Size: 24 by 24 inches.
 - 5. Thickness: 2 inches.
 - 6. Color: Selected from manufacturer's full range.
- B. Installation Systems: Terra-Adjust Adjustable Pedestal as manufactured by Wausau Tile Co.
 - 1. Provide all Tabs, Shim Plates, tools and accessories for a complete system installation to meet the intent of the scope of work defined per the Drawings.
- C. Sand for Setting Bed: Clean washed natural sand or crushed stone complying with gradation requirements of ASTM C33/C33M for fine aggregates.

- D. Sand for Joints: Fine washed sand with 100 percent passing No. 16 sieve and not more than 10 percent passing No. 200 sieve.
- E. Edging: Formed aluminum, as detailed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate is level or to correct gradient, smooth, capable of supporting pavers and imposed loads, and ready to receive work of this Section.
- B. Verify gradients and elevations of substrate are correct.

3.02 INSTALLATION OF SOLID PAVER UNITS

- A. Spread sand evenly over prepared substrate surface to a maximum thickness of 1-1/2 inch.
- B. Dampen and roller compact sand to level and even surface.
- C. Screed and scarify top 1/2 inch of sand.
- D. Place paver units in pattern indicated on the drawings.
- E. Cut paver units at edges with masonry saw.
- F. Place half units at edge and interruptions. Maintain tight joints.
- G. At Pavers on Grade: Sprinkle sand over surface and sweep into joints. Moisten joints and recover with additional sand until firm joints are achieved. Remove excess sand.
 - 1. Tamp and level paver units with mechanical vibrator until units are firmly bedded, level, and to correct elevation and gradients. Do not tamp unrestrained edges.

END OF SECTION