

**SPECIFICATIONS
FOR
DELAWARE STATE UNIVERSITY
JOHN R. PRICE BUILDING – FIRST FLOOR, SOUTH WING HVAC
RENOVATIONS
BIDDING DOCUMENTS**

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SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 07 01 50.19 - Preparation for Re-Roofing: Removal of existing roofing, roof insulation, flashing, trim, and accessories.

1.03 REFERENCE STANDARDS

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

PART 3 EXECUTION

2.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Provide, erect, and maintain temporary barriers and security devices.
 - 2. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 3. 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.
- B. Do not begin removal until built elements to be salvaged or relocated have been removed.
- C. 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.
- D. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.

2.02 EXISTING UTILITIES

- A. Protect existing utilities to remain from damage.
- B. 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.
- C. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 7 days prior written notification to Owner.
- D. 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.
- E. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

2.03 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. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
- C. 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.
- D. Services (Including but not limited to HVAC, Plumbing, Electrical, and Telecommunications): 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.
- E. 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.

2.04 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Remove from site all materials not to be reused on site; .
- C. Leave site in clean condition, ready for subsequent work.
- D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 04 05 11
MASONRY MORTARING AND GROUTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Mortar for unit masonry.
- B. Grout for masonry.
- C. Mortar for cast stone masonry.

1.02 RELATED REQUIREMENTS

- A. Section 04 20 00 - Unit Masonry: Installation of mortar and grout.
- B. Section 04 72 00 - Cast Stone Masonry
- C. See Structural Drawings for additional Project Specifications. If Conflicting Project Specifications arise, the Project Specifications on the Structural Drawings govern.

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.
- B. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures; American Concrete Institute International.
- C. ASTM C5 - Standard Specification for Quicklime for Structural Purposes.
- D. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
- E. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
- F. ASTM C150/C150M - Standard Specification for Portland Cement.
- G. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
- H. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
- I. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
- J. ASTM C476 - Standard Specification for Grout for Masonry.
- K. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- L. ASTM C1019 - Standard Test Method for Sampling and Testing Grout.
- M. ASTM C1072 - Standard Test Method for Measurement of Masonry Flexural Bond Strength.
- N. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
- O. ASTM E518 - Standard Test Methods for Flexural Bond Strength of Masonry.
- P. IMIABC (CW) - Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; 1993.
- Q. IMIABC (HW) - Recommended Practices & Guide Specifications for Hot Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include design mix based on the Proportion specification of ASTM C 270 is to be used.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 FIELD CONDITIONS

- A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 MORTAR AND GROUT APPLICATIONS

- A. At Contractor's option, mortar and grout may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
- B. Mortar Mix Designs: ASTM C270, Property Specification.

2.02 MATERIALS

- A. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - 1. Color: Mineral pigments added as required to produce approved color sample.
 - 2. Products:
 - a. Amerimix, an Oldcastle brand; AMX 400: www.amerimix.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Masonry Cement: ASTM C91.
 - 1. Type: Type N.
 - 2. Colored Mortar: Premixed cement as required to match Architect's color sample.
 - 3. Manufacturers:
 - a. Solomon Colors; Solomon Colors Concentrated A, H, and X Series: www.solomoncolors.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Portland Cement: ASTM C 150, Type I - Normal; color as required to produce approved color sample. Color must match existing building mortar color.
- D. Hydrated Lime: ASTM C207, Type S.
- E. Quicklime: ASTM C5, non-hydraulic type.
- F. Mortar Aggregate: ASTM C144.
- G. Grout Aggregate: ASTM C404.
- H. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
 - 1. Color(s): As selected by Architect from manufacturer's full range, to match existing mortar.
 - 2. Manufacturers:
 - a. Davis Colors
 - b. Lambert Corporation
 - c. Solomon Colors

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

I. Water: Clean and potable.

2.03 MORTAR MIXES

- A. Mortar for Unit Masonry: ASTM C270, Property Specification.
 - 1. Exterior, non-loadbearing masonry: Type N.
 - 2. Interior, non-loadbearing masonry: Type N.

2.04 MORTAR MIXING

- A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
- B. Maintain sand uniformly damp immediately before the mixing process.
- C. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio; mix in accordance with manufacturer's instructions, uniform in coloration.
- D. Do not use anti-freeze compounds to lower the freezing point of mortar.
- E. If water is lost by evaporation, re-temper only within two hours of mixing.
- F. Use mortar within two hours after mixing at temperatures of 90 degrees F, or two-and-one-half hours at temperatures under 40 degrees F.

PART 3 EXECUTION

3.01 PREPARATION

- A. Apply bonding agent to existing Masonry surfaces.
- B. Plug clean-out holes for grouted masonry with Brick or block masonry units. Brace masonry to resist wet grout pressure.

3.02 INSTALLATION

- A. Install mortar and grout to requirements of section(s) in which masonry is specified.
- B. Work grout into masonry cores and cavities to eliminate voids.
- C. Do not install grout in lifts greater than 16 inches without consolidating grout by rodding.
- D. Do not displace reinforcement while placing grout.
- E. Remove excess mortar from grout spaces.

END OF SECTION

SECTION 04 20 00

UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete Block.
- B. Clay Facing Brick.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 04 05 11 - Masonry Mortaring and Grouting.
- B. Section 07 90 05 - Joint Sealers: Backing rod and sealant at control and expansion joints.

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.
- B. ACI 530.1/ASCE 6/TMS 602 - Specification For Masonry Structures; American Concrete Institute International.
- C. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A580/A580M - Standard Specification for Stainless Steel Wire.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- G. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- J. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
- K. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
- L. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
- M. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
- N. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units.
- O. ASTM C140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units.
- P. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
- Q. ASTM C150/C150M - Standard Specification for Portland Cement.
- R. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
- S. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale).
- T. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
- U. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
- V. ASTM C476 - Standard Specification for Grout for Masonry.

- W. ASTM C652 - Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
- X. ASTM C744 - Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
- Y. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- Z. IMIABC (CW) - Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; 1993.
- AA. IMIABC (HW) - Recommended Practices & Guide Specifications for Hot Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.
- AB. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc..

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, mortar, and masonry accessories.
- C. Samples: Submit four samples of concrete block units to illustrate color, texture, and extremes of color range.
- D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.
 - 1. Maintain one copy of each document on project site.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

1.08 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Provide 50 of each size, color, and type of brick units for Owner use in maintenance of project.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete Block: 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. Non-Loadbearing Units: ASTM C129.
 - a. Both hollow and solid block, as indicated.
 - b. Normal weight.
 - c. Exposed corners to be bull nose. Note wall type where first course is square to accommodate cove base.

2.02 BRICK UNITS

- A. Manufacturers:
 - 1. Belden Brick Company: www.boralbricks.com.
 - 2. Endicott Clay Products Co: www.endicott.com.
 - 3. General Shale Brick: www.generalshale.com.
 - 4. Glen Gery Brick . www.glengerybrick.com
 - 5. Substitutions: See section 01 60 00 - Product requirements.
- B. Facing Brick: ASTM C216, Type FBX, Grade SW.
 - 1. Type, color and texture: to match existing brick.
 - 2. Actual size: to match existing brick.
 - 3. Compressive strength: Min. 2,500 p.s.i.; 5 brick average = 3,000 p.s.i, measured in accordance with ASTM C 67.

2.03 MORTAR AND GROUT MATERIALS

- A. Mortar and grout: As specified in Section 04 05 11.

2.04 REINFORCEMENT AND ANCHORAGE

- A. Manufacturers of Joint Reinforcement and Anchors:
 - 1. Dur-O-Wal: www.dur-o-wal.com.
 - 2. Hohmann & Barnard, Inc: www.h-b.com.
 - 3. WIRE-BOND: www.wirebond.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Single Wythe Joint Reinforcement: Truss or Ladder type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B-2; 0.1483 inch side rods with 0.1483 inch 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.
- C. Strap Anchors: Bent steel shapes configured as required for specific situations, 2 in width, 0.1875 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A 153/A 153M, Class B-2 or stainless steel.
- D. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.
 - 1. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B-2.
- E. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A 153/A 153M, Class B-2, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in.

2.05 ACCESSORIES

- A. Preformed Control Joints: Rubber or neoprene material.
 - 1. Manufacturers:
 - a. Dur-O-Wal: www.dur-o-wal.com.
 - b. Hohmann & Barnard, Inc (including Dur-O-Wal brand); Product RS or VS: www.h-b.com.
 - c. WIRE-BOND: www.wirebond.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Joint Filler: Closed cell polyethylene; polyurethane or rubber oversized 50 percent to joint width; self expanding; 1 inch wide design width x by maximum lengths available.

1. Manufacturers:
 - a. Dur-O-Wal; Product Mortar Net: www.dur-o-wal.com.
 - b. Hohmann & Barnard, Inc (including Dur -O-Wal brand); Product P.E. Foam Expansion unit fuller: www.h-b.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.06 MORTAR AND GROUT MIXES

- A. Mortar and Grout mixes as specified in Section 04 05 11.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Direct and coordinate placement of items supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. 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. Set reglets as shown on plans.
- H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- I. Cut mortar joints flush where wall tile is scheduled, cement parging is required, or resilient base is scheduled. Block exposed cavity space with raiseable steel guard of correct width.
- J. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- K. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.04 REINFORCEMENT AND ANCHORAGE - GENERAL

- A. Fasten anchors to structural framing 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.

3.05 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control and expansion joints.

- B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.
- C. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- D. Size control joint in accordance with Section 07 90 05 for sealant performance.
- E. Form expansion joint as detailed.
- F. Locate per drawings.

3.06 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames, glazed frames, fabricated metal frames, window frames, anchor bolts, plates, and boxes 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.

3.07 TOLERANCES

- A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft.
- C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 20ft.
- E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
- F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.08 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, conduit, sleeves, and grounds. 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.

3.09 FIELD QUALITY CONTROL

- A. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140 for conformance to requirements of this specification.
- B. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.10 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

3.11 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preservative treated wood materials.
- B. Fire retardant treated wood materials.
- C. Wood nailers and curbs for roofing and items installed on roof.

1.02 RELATED REQUIREMENTS

- A. Section 07 62 00 - Sheet Metal Flashing and Trim: Drip flashings.
- B. Section 09 21 16 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- C. ASTM D2898 - Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood Protection Association.
- F. AWPA C20 - Structural Lumber -- Fire Retardant Treatment by Pressure Processes; American Wood-Protection Association.
- G. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood Protection Association.
- H. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc.
- I. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce).
- J. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc..

1.04 QUALITY ASSURANCE

- A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
 - 1. 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. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
- C. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

2.01 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M; or Stainless Steel for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2.02 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.
- B. Fire Retardant Treatment:
 - 1. Manufacturers:
 - a. Arch Wood Protection, Inc: www.wolmanizedwood.com.
 - b. Hoover Treated Wood Products, Inc: www.frtw.com.
 - c. Osmose, Inc: www.osmose.com.
 - d. Substitutions: Not permitted.
 - 2. Exterior Type: AWPA U1, 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, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Do not use treated wood in direct contact with the ground.
 - 3. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as scheduled; or as indicated.
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 - 1. Manufacturers:
 - a. Arch Wood Protection, Inc.: www.wolmanizedwood.com.
 - b. Viance, LLC: www.treatedwood.com.
 - c. Osmose, Inc: www.osmose.com.
 - d. Substitutions: Not permitted.
- D. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.
 - 1. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - 2. Treat lumber in contact with roofing, flashing, or waterproofing.
 - 3. Treat lumber in contact with masonry or concrete.

4. Treat lumber less than 18 inches above grade.
 - a. Treat lumber in other locations as indicated.
5. Preservative Pressure Treatment of Plywood Above Grade: AWPAC U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention.
 - a. Kiln dry plywood after treatment to maximum moisture content of 15 percent.
 - b. Treat plywood in contact with masonry or concrete.
 - c. Treat plywood in other locations as indicated.
- E. Preservative Pressure Treatment of Lumber in Contact with Soil: AWPAC U1, Use Category UC4A, Commodity Specification A using waterborne preservative to 0.4 lb/cu ft retention.
 1. Preservative for Field Application to Cut Surfaces: As recommended by manufacturer of factory treatment chemicals for brush-application in the field.
 2. Restrictions: Do not use lumber or plywood treated with chromated copper arsenate (CCA) in exposed exterior applications subject to leaching.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

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

3.02 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

3.03 ROOF-RELATED CARPENTRY

- A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.

3.04 INSTALLATION OF ACCESSORIES AND MISCELLANEOUS WOOD

- A. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.
- B. Coordinate curb installation with installation of decking and support of deck openings, roofing vapor retardant, and parapet construction.

3.05 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Surface Flatness of Floor: 1/8 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.
- C. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.06 CLEANING

- A. Waste Disposal: Comply with the requirements of Section 01 77 00.
 1. Comply with applicable regulations.
 2. Do not burn scrap on project site.
 3. Do not burn scraps that have been pressure treated.
 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

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

END OF SECTION

SECTION 07 01 50.19
PREPARATION FOR RE-ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal of existing roofing system in preparation for a new roof membrane system.

1.02 REFERENCE STANDARDS

- A. ASTM C208 - Standard Specification for Cellulosic Fiber Insulating Board.

1.03 PROJECT CONDITIONS

- A. Schedule work to coincide with commencement of installation of new roofing system.
- B. Remove only existing roofing materials that can be replaced with new materials the same day.
- C. Coordinate the work with other affected mechanical and electrical work associated with roof penetrations.

1.04 FIELD CONDITIONS

- A. Do not remove existing roofing membrane when weather conditions threaten the integrity of the building contents or intended continued occupancy.
- B. Maintain continuous temporary protection prior to and during installation of new roofing system.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Temporary Protection: Sheet fiber reinforced plastic; provide weights to retain sheeting in position.
- B. Protection Board: ASTM C 208 cellulose fiber board, one face or both faces finished with mineral fiber, asphalt and kraft paper, with the following characteristics.
 - 1. Board Size: 48 x 96 inch.
 - 2. Board Thickness: 1 inch.
 - 3. Thermal Conductivity: K factor of 0.36.
 - 4. Board Edges: Square or Shiplapped.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing roof surface is clear and ready for work of this section.

3.02 PREPARATION

- A. Sweep roof surface clean of loose matter.
- B. Remove loose refuse and legally dispose off site.

3.03 MATERIAL REMOVAL

- A. Fold up metal counter flashings to permit access to top edge of base flashings.
- B. Remove roofing membrane, perimeter base flashings, flashings around roof protrusions.

3.04 PROTECTION

- A. Provide temporary protective sheeting over undercovered deck surfaces.
- B. Turn sheeting up and over parapets and curbing. Retain sheeting in position with weights.
- C. Provide for surface drainage from sheeting to existing drainage facilities.
- D. Do not permit traffic over unprotected or repaired deck surface.

3.05 SCHEDULES

- A. Roof areas as indicated. Remove existing perimeter flashings; base flashings; vent stack flashings; roofing membrane; insulation and vapor retarder.
- B. Remove roof mounted mechanical equipment and electrical equipment. Roof penetrations designated to be demolished.

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. Reglets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Wood nailers.
- B. Section 07 90 05 - Joint Sealers.

1.03 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association.
- B. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
- C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- G. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
- H. ASTM D2178 - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
- I. ASTM D4479/D4479M - Standard Specification for Asphalt Roof Coatings - Asbestos-Free.
- J. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free.
- K. CDA A4050 - Copper in Architecture - Handbook; Copper Development Association, Inc..
- L. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, by roofing manufacturer except as otherwise indicated.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

- B. Prevent contact with materials that could cause discoloration or staining.

1.07 PROJECT CONDITIONS

PART 2 PRODUCTS

2.01 SHEET MATERIALS

- A. Pre-finished Aluminum: ASTM B209 (ASTM B209M), 3005 alloy, H12 or H14 temper; .050 inch thick or as noted on plans; plain finish; shop re-located with fluoropolymer (70% kynar 500) coating system; custom color to match existing roof.

2.02 ACCESSORIES

- A. Fasteners: Stainless steel, with soft neoprene washers.
- B. Primer: Zinc chromate type.
- C. Protective Backing Paint: Zinc molybdate alkyd.
- D. Sealant: Type specified in Section 07 90 05.
- E. Plastic Cement: ASTM D4586, Type I.
- F. Reglets: Recessed type, rigid extruded PVC; face and ends covered with plastic tape .

2.03 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats of same material as sheet, continuous wide, interlocking with sheet.
- C. Form pieces in longest possible lengths.
- D. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- E. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- F. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
- G. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION

- A. Conform to drawing details.
 - 1. Per drawings or: SMACNA Architectural Sheet Metal Manual .
- B. Set continuous cleats.
- C. Insert flashings into reglets to form tight fit. Secure in place with lead wedges. Seal flashings into reglets with sealant.
- D. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted. Flash in accordance with roof manufacturer's instructions, using standard details.

- E. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- F. Seal metal joints watertight.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 45 00 - Quality Requirements, for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- B. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- C. ASTM E1966 - Standard Test Method for Fire Resistive Joint Systems.
- D. ASTM E2837 - Standard Test Method for Determining Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
- E. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc..
- F. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation.
- G. FM P7825 - Approval Guide; Factory Mutual Research Corporation.
- H. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; www.aqmd.gov.
- I. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Underwriters Laboratories Inc..
- J. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc..

1.04 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. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Certificate from authority having jurisdiction indicating approval of materials used.
- G. Qualification statements for installing mechanics.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in 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. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- 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. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors, or meeting any two of the following requirements:
 - 2. With minimum 5 years documented experience installing work of this type.
 - 3. Able to show at least 3 satisfactorily completed projects of comparable size and type.
 - 4. Licensed by authority having jurisdiction.
 - 5. Approved by firestopping manufacturer.
- D. Installing Mechanic's Qualifications: Trained by firestopping manufacturer and able to provide evidence thereof.

1.06 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 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. Manufacturers:
 - 1. A/D Fire Protection Systems Inc: www.adfire.com.
 - 2. 3M Fire Protection Products: www.3m.com/firestop.
 - 3. Hilti, Inc: www.us.hilti.com.
 - 4. Nelson FireStop Products: www.nelsonfirestop.com.
- B. 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.
- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. 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.
- B. 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.
 - 4. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.
- C. 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. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.

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

- A. Concrete and Concrete Masonry Walls and Floors:
 1. 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.
 - b. 2 Hour Construction: UL System HW-D-1037; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 2. 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. 2 Hour Construction: UL System WW-D-0032; Hilti CP 606 Flexible Firestop Sealant.
- 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.

2.04 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

- A. Blank Openings:
 1. In Walls:
 - a. 2 Hour Construction: UL System C-AJ-0090; Hilti FS-ONE Intumescent Firestop Sealant.
- B. Penetrations Through Walls By:
 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System C-AJ-8143; Hilti FS-ONE Intumescent Firestop Sealant.
 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-1421; Hilti FS-ONE Intumescent Firestop Sealant or CP 604 Self-Leveling Firestop Sealant.
 - b. 2 Hour Construction: UL System C-AJ-1498; Hilti CP 680-P/M Cast-In Device.
 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-2109; Hilti CP 643N/644 Firestop Collar.
 - b. 2 Hour Construction: UL System C-BJ-2021; Hilti CP 643N Firestop Collar.
 4. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System C-AJ-3216; Hilti CP 658 Firestop Plug.
 - b. 2 Hour Construction: UL System W-J-3198; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
 - c. 2 Hour Construction: UL System W-J-3199; Hilti CFS-SL SK Firestop Sleeve Kit.
 5. Insulated Pipes:
 - a. 2 Hour Construction: UL System C-AJ-5048; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 601S Elastomeric Firestop Sealant, or CP 604 Self-Leveling Firestop Sealant.
- C. Penetrations Through Walls By:

1. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE Intumescent Firestop Sealant.
2. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System W-J-3060; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
 - b. 2 Hour Construction: UL System W-J-3143; Hilti CP 658T Firestop Plug.
3. Insulated Pipes:
 - a. 2 Hour Construction: UL System W-J-5041; Hilti FS-ONE Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-J-5042; Hilti FS-ONE Intumescent Firestop Sealant.
 - c. 2 Hour Construction: UL System W-J-5028; Hilti FS-ONE Intumescent Firestop Sealant.
4. HVAC Ducts, Uninsulated:
 - a. 2 Hour Construction: UL System W-J-7109; Hilti FS-ONE Intumescent Firestop Sealant or CP 606 Flexible Firestop Sealant.
5. HVAC Ducts, Insulated:
 - a. 2 Hour Construction: UL System W-J-7112; Hilti FS-ONE 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.
- 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. 2 Hour Construction: UL System W-L-1408; Hilti FS-ONE Intumescent Firestop Sealant.
 - c. 2 Hour Construction: UL System W-L-8071; Hilti FS-ONE Intumescent Firestop Sealant.
 - d. 2 Hour Construction: UL System W-L-8079; Hilti FS-ONE Intumescent Firestop Sealant.
 - e. 2 Hour Construction: UL System W-L-8087; Hilti FS 657 Fire Block.
 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-L-1054; Hilti FS-ONE Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-L-1164; Hilti FS-ONE Intumescent Firestop Sealant.
 - c. 2 Hour Construction: UL System W-L-1206; Hilti FS-ONE Intumescent Firestop Sealant.
 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
 - b. 2 Hour Construction: UL System W-L-2411; Hilti CP 648-E Firestop Wrap Strip.
 - c. 2 Hour Construction: UL System W-L-2128; Hilti FS-ONE Intumescent Firestop Sealant.
 4. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System W-L-3065; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.

- b. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
- c. 2 Hour Construction: UL System W-L-3393; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
- d. 2 Hour Construction: UL System W-L-3394; Hilti CFS-SL SK Firestop Sleeve Kit.
- e. 2 Hour Construction: UL System W-L-3395; Hilti CP653 Speed Sleeve.
- 5. Insulated Pipes:
 - a. 2 Hour Construction: UL System W-L-5028; Hilti FS-ONE Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.
 - c. 2 Hour Construction: UL System W-L-5096; Hilti FS-ONE Intumescent Firestop Sealant.
 - d. 2 Hour Construction: UL System W-L-5257; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, or CP 601S Elastomeric Firestop Sealant.
 - e. 2 Hour Construction: UL System W-L-5244; Hilti CP 648-E Firestop Wrap Strip.

2.06 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements. Foam, caulk, putty or manufactured device.
 - 1. Fire Ratings: Use any system listed by UL, FM, or ITS (Warnock Hersey) or that has F Rating equal to fire rating of penetrated assembly and minimum T Rating of 0 and that meets all other specified requirements.
 - 2. Fire Ratings: See Drawings for required systems and ratings.
- B. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements. Foam, caulk, putty or manufactured device.
- C. Firestopping at Cable Tray Penetrations: Any material meeting requirements. Foam, caulk, putty or manufactured device.
- D. Firestopping at Cable Penetrations, not in Conduit or Cable Tray: Any material meeting requirements. Foam, caulk, putty or manufactured device.
- E. Firestopping at Control and Expansion Joints (without Penetrations): Any material meeting requirements and caulk.

2.07 MATERIALS

- A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
- C. Foam Firestoppping: Single component silicone foam compound.
- D. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers.
- E. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening.
- F. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.
- C. Install labeling required by code.

CLEANING

4.01 CLEAN ADJACENT SURFACES OF FIRESTOPPING MATERIALS.

4.02 PROTECTION

- A. Clean adjacent surfaces of firestopping materials.
- 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 backer rods.
- B. Precompressed foam sealers.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping: Firestopping sealants.

1.03 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants.
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- E. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber.
- F. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Poly(Vinyl Chloride) Foam (Closed-Cell).
- G. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; www.aqmd.gov.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.
- C. Samples: Submit two samples, 2 x 1/2 in size illustrating sealant colors for selection.
- D. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 10 years documented experience.
- B. Applicator Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.

1.06 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 COORDINATION

- A. Coordinate the work with all sections referencing this section.

1.08 WARRANTY

- A. See Section 01 77 00 - Closeout Submittals, for additional warranty requirements.
- B. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Polyurethane Sealants:
 - 1. Pecora Corporation: www.pecora.com.
 - 2. Bostik, Inc www.bostik-us.com
 - 3. BASF Construction Chemicals-Building Systems: www.chemrex.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Acrylic Sealants (ASTM C920):
 - 1. Pecora Corporation; www.pecora.com.
 - 2. Tremco, Inc www.tremcosealants.com.
 - 3. Bostik, Inc. www.bostik-us.com.
- C. Preformed Compressible Foam Sealers and backer rods:
 - 1. Sandell Manufacturing Company, Inc: www.sandellmfg.com.
 - 2. Emseal Joint Systems, Ltd.
 - 3. Dayton Superior Corporation: www.daytonsuperior.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 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. Type 1 - General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25, Uses M, G, and A; single component.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Product: Dynatrol II manufactured by Pecora.
 - 3. Applications: Use for:
 - a. Control, expansion, and soft joints in masonry.
 - b. Joints between concrete and other materials.
 - c. Joints between metal frames and other materials.
 - d. Concealed sealant beads in roofings sheet metal work.
 - e. Other exterior joints for which no other sealant is indicated.
- C. Type 2 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NF single component, paintable.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Product: AC-20 + Silicone manufactured by Pecora.
 - 3. Applications: Use for:
 - a. Interior wall and ceiling control joints.
 - b. Joints between door and window frames and wall surfaces.
 - c. Other interior joints for which no other type of sealant is indicated.
- D. Type 3 - Exterior Expansion Joint Sealer: ASTM D 2628, hollow neoprene (polychloroprene) compression gasket.
 - 1. Black color.
 - 2. Size and Shape: . As indicated by drawings.
 - 3. Product: Poly seal manufactured by sandell mfg.
 - 4. Applications: Use for:
 - a. Exterior wall expansion joints.
- E. Type 4 - Acoustical Sealant: acrylic sealant; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
 - 1. Product: AIS-919 manufactured by Pecora.

2. Applications: Use for concealed locations only:
 - a. Where shown on plans.
- F. Type 5 - Concrete Paving Joint Sealant: Polyurethane, self-leveling; ASTM C920, Class 25, Uses T, I, M and A; single component.
 1. Color: Gray.
 2. Product: Dynatred manufactured by Pecora.
 3. Applications: Use for:
 - a. Joints in sidewalks and vehicular paving.
 - b. Where shown on plans.
- G. Type 6 - Exterior Metal Lap Joint Sealant: Butyl or polyisobutylene, nondrying, nonskinning, noncuring.

2.03 ACCESSORIES

- A. Primer: 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: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. 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.

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. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- E. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
 1. Width/depth ratio of 2:1.
 2. Neck dimension no greater than 1/3 of the joint width.
 3. Surface bond area on each side not less than 75 percent of joint width.
- F. Install bond breaker where joint backing is not used.
- G. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

- H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- I. Tool joints concave.
- J. 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.
- K. Compression Gaskets: 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.

3.04 CLEANING

- A. Clean adjacent soiled surfaces.

3.05 PROTECTION

- A. Protect sealants until cured.

3.06 SCHEDULE

- A. Exterior Joints for Which No Other Sealant Type is Indicated: Type 1; colors as selected.
- B. Control, Expansion, and Soft Joints in Masonry, and Between Masonry and Adjacent Work: Type 1.
- C. Lap Joints in Exterior Sheet Metal Work: Type 1 or 6 .
- D. Butt Joints in Exterior Metal Work and Siding: Type 1.
- E. Joints Between Exterior Metal Frames and Adjacent Work (except masonry): Type 1.
- F. Interior Joints for Which No Other Sealant is Indicated: Type 2; colors as shown on the drawings.
- G. Joints Between Plumbing Fixtures and Walls and Floors, and Between Countertops and Walls: Type 2.
- H. In STC-Rated Walls, Between Metal Stud Track/Runner and Adjacent Construction and Between Outlet Boxes and Gypsum Board: Type 4.

END OF SECTION

SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal stud wall, ceiling and soffit framing.
- B. Gypsum wallboard.
- C. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Building Framing and Wood blocking .
- B. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 REFERENCE STANDARDS

- A. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute. (replaced SG-971)
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- D. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board.
- E. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members.
- F. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- G. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- H. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
- 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.
- J. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- K. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
- L. ASTM C1396/C1396M - Standard Specification for Gypsum Board.
- M. ASTM C1629/C1629 - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
- N. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- P. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- Q. ASTM E413 - Classification for Rating Sound Insulation.
- R. GA-214 - Recommended Levels of Gypsum Board Finish; Gypsum Association.
- S. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate special details associated with vertical deflection joints and acoustic seals. Provide special details for suspended ceilings. Indicate layout, anchorage to structure, type and location of fasteners, framed openings, accessories, and items of related work.
- C. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.05 QUALITY ASSURANCE

- A. Perform in accordance with ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies.
- B. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 5 years of documented experience.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies per drawings.

2.02 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com.
 - 2. Dietrich Metal Framing: www.dietrichindustries.com.
 - 3. Marino: www.marinoware.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/360 at 5 psf.
 - 1. Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
 - a. Acceptable Products:
 - 1) Dietrich Metal Framing; UltraSteel (tm): www.dietrichindustries.com.
 - 2) Clark Western Building Systems; UltraSteel (tm): www.clarkwestern.com.
 - 2. Studs: "C" shaped with flat or formed webs with knurled faces. Minimum gauge = 20.
 - 3. Runners: U shaped, sized to match studs. Minimum gauge = 16.
 - 4. Ceiling Channels: C shaped. Minimum gauge = 16.
 - 5. Furring: Hat-shaped sections, minimum depth of 7/8 inch. Minimum gauge = 18.
- C. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
- D. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot dipped galvanized coating.

3. Provide kickers / framing for top of wall and soffits as necessary.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 1. CertainTeed Corporation: www.certainteed.com.
 2. Georgia-Pacific Gypsum: www.gpgypsum.com.
 3. National Gypsum Company: www.nationalgypsum.com.
 4. USG Corporation: www.usg.com.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Impact-Rated Wallboard: Tested to Level 3 soft-body and hard-body impact in accordance with ASTM C1629.
 1. Application: Walls.
 2. Paper-Faced Type: Gypsum wallboard as defined in ASTM C1396/C1396M.
 3. Thickness: 5/8 inch.
 4. Edges: Tapered.
 5. Products:
 - a. National Gypsum Company; Gold Bond Hi-Impact Brand XP Wallboard.
 - b. USG Corporation; Fiberock Brand Panels--VHI Abuse-Resistant.
- C. Gypsum Wallboard: ASTM C 1396/C 1396M. Sizes to minimize joints in place; ends square cut.
 1. Abuse-Resistant Type: Gypsum wallboard especially formulated for increased impact resistance, with enhanced gypsum core and heavy duty face and back paper.
 - a. Application: Walls.
 - b. Core Type: Regular, as indicated.
 - c. Thickness: 5/8 inch.
 - d. Edges: Tapered.

2.04 ACCESSORIES

- A. Acoustic Insulation: ASTM C 665; preformed glass fiber, friction fit type, unfaced. Thickness to fit cavity. As specified in Section 07 21 00.
- B. Finishing Accessories: ASTM C1047, rigid plastic, unless otherwise indicated.
 1. Types: As detailed or required for finished appearance.
 2. Special Shapes: In addition to conventional cornerbead and control joints, provide U-bead at exposed panel edges.
- C. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
 1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 2. Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 3. Ready-mixed vinyl-based joint compound.
 4. Powder-type vinyl-based joint compound.
 5. Chemical hardening type compound.
- D. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.
- E. Screws for Attachment to Steel Members From 0.033 to 0.112 Inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.
- F. Screws: ASTM C 1002; self-piercing tapping type; cadmium-plated for exterior locations.
- G. Staples: ASTM C 840.

- H. Anchorage to Substrate: Tie wire, screws, and other metal supports, of type and size to suit application; to 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 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Studs: Space studs as indicated.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling framing in accordance with details.
 - 3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
 - 4. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- C. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- D. Connections: Minimum (4) #12 screws per connection of cold formed metal framing members.
- E. Blocking: Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, wood frame openings, toilet accessories, and hardware. Comply with Section 06 10 00 for wood blocking.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

3.04 BOARD INSTALLATION

- A. Comply with ASTM C 840 and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
 - 1. Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Installation on Metal Framing: Use screws for attachment of all gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as directed.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.06 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use fiberglass joint tape, bedded with ready-mixed vinyl-based; or powder-type vinyl-based; or chemical hardening type joint compound and finished with ready-mixed vinyl-based; or powder-type vinyl-based; or chemical hardening type joint compound.

- B. 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 2: In utility areas, behind cabinetry, and on backing board to receive tile finish or where FRP panel to be installed.
 - 3. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- C. Finish gypsum board in scheduled areas in accordance with levels defined in GA-214; or ASTM C 840 and as scheduled below.
 - 1. Above Finished Ceilings Concealed From View: Level 1.
 - 2. Walls and Ceilings to Receive Flat Paint Finish: Level 4.
- 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 surfaces behind adhesive applied ceramic tile and fixed cabinetry.
 - 3. Taping, filling and sanding is not required at base layer of double layer applications.

3.07 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.08 FINISH LEVEL SCHEDULE (SEE 1.03 REFERENCES FOR DEFINITION)

- A. Level 1: Above finished ceilings concealed from view.
- B. Level 4: Walls and ceilings scheduled to receive flat paint finish.

END OF SECTION

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system to facilitate new window installation.
- B. Support hangers, channels, and wires.

1.02 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Acoustical insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C635 - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
- C. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.
- D. GEI (SCH) - GREENGUARD "Children and Schools" Certified Products; GREENGUARD Environmental Institute.

1.04 SUBMITTALS

- A. See Section 01 30 00 - General Conditions, for submittal procedures.
- B. Product Data: Provide data on suspension system components.
- C. Samples: Submit two samples 4x4 inch in size illustrating material and finish of acoustical units.
- D. Samples: Submit two samples each, 6 inches long, of suspension system main runner, cross runner, and perimeter molding.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

1.06 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.07 PROJECT CONDITIONS

- 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. Install acoustical units after interior wet work is dry.

1.08 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Provide 800 SF of Type A acoustical unit, 160 SF of Type B acoustical unit, 48 SF of Type C, and 48 SF of Type D for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

- A. Manufacturers:
 - 1. Armstrong World Industries, Inc: www.armstrong.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Acoustical Units - General: ASTM E1264, Class A.
- C. Acoustical Tile Type A: Painted mineral fiber, ASTM E 1264 Type III, with to the following characteristics:
 - 1. Size: 24 x 48 inches.
 - 2. Edge: Square.
 - 3. Surface Color: White.
 - 4. Surface Pattern: Fine Fissured, match existing..
 - 5. Product: Armstrong

2.02 SUSPENSION SYSTEM(S) UNLESS NOTED OTHERWISE ABOVE.

- A. Manufacturers:
 - 1. Same as for acoustical units.
 - 2. Armstrong World Industries, Inc: www.armstrong.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Suspension Systems - General: ASTM C 635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
- C. Exposed Tee Steel Suspension System: Formed galvanized steel, commercial quality cold rolled; heavy-duty.
 - 1. Profile: Tee; for square edge panels 15/16 inch wide face.
 - 2. Construction: Double web.
 - 3. Finish: White painted.
 - 4. Product: Match existing by Armstrong.

2.03 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
- B. Perimeter Moldings: Same material and finish as grid.
- C. Acoustical Sealant For Perimeter Moldings: Specified in Section 07 90 05.
- D. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.
- E. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C 636, ASTM E 580, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:240.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.

- D. Locate system on room axis according to reflected plan.
- E. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- F. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- I. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- J. Do not eccentrically load system or induce rotation of runners.
- K. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Install in bed of acoustical sealant or with continuous gasket.
 - 2. Use longest practical lengths.
 - 3. Miter or Overlap and rivet corners.
- L. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.

3.03 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.

END OF SECTION

SECTION 09 65 00
RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient tile flooring.
- B. Resilient base.
- C. Installation accessories.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
- B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- C. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile.
- D. ASTM F1861 - Standard Specification for Resilient Wall Base.
- E. CAL (CHPS LEM) - Low-Emitting Materials Product List; California Collaborative for High Performance Schools (CHPS).
- F. GEI (SCH) - GREENGUARD "Children and Schools" Certified Products; GREENGUARD Environmental Institute.
- G. RFCI - Recommended Work Practices for Removal of Resilient Floor Coverings; Resilient Floor Covering Institute.
- H. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; www.aqmd.gov.
- I. SCS (CPD) - SCS Certified Products; Scientific Certification Systems.

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. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
- D. Verification Samples: Submit two samples, 6x6 inch in size illustrating color and pattern for each resilient flooring product specified.

1.05 FIELD CONDITIONS

- A. Maintain temperature in storage area between 55 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.

PART 2 PRODUCTS

2.01 SHEET FLOORING

2.02 TILE FLOORING

- A. Vinyl Composition Tile: Homogeneous, with color extending throughout thickness, and:
 - 1. Minimum Requirements: Comply with ASTM F 1066, of Class corresponding to type specified. Composition 1, class 2.

2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648.
3. Size: 12 x 12 inch.
4. Thickness: 0.125 inch.
5. Pattern: Match existing.
6. Manufacturers:
 - a. Armstrong World Industries, Inc; Product Standard Excelon Multicolor: www.armstrong.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 RESILIENT BASE

- A. Resilient Base: ASTM F 1861, Type TS rubber, vulcanized thermoset; top set cover and as follows:
 1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
 2. Height: Match existing.
 3. Thickness: 0.125 inch thick.
 4. Finish: Matte.
 5. Length: Roll.
 6. Color: Color as selected from manufacturer's standards.
 7. Accessories: Premolded external corners and end stops.
 8. Manufacturers:
 - a. Burke Flooring: www.burkemercer.com.
 - b. Johnsonite, Inc: www.johnsonite.com.
 - c. Roppe Corp: www.roppe.com.

2.04 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
 1. Provide only products having lower volatile organic compound (VOC) content than required by the more stringent of the South Coast Air Quality Management District Rule No.1168 and the Bay Area Air Quality Management District Regulation 8, Rule 51.
- C. Moldings and Edge Strips: Rubber.
 1. Products: manufactured by Roppe.
- D. Filler for Coved Base: Plastic or as recommended by manufacturer.
- E. Sealer and Wax: Types recommended by flooring manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive resilient flooring.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.

3.02 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 sub-floor surfaces as recommended by flooring and adhesive manufacturers.
- C. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
- D. Prohibit traffic until filler is cured.
- E. Clean substrate.
- F. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 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 edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 TILE FLOORING

- A. Install in accordance with manufacturer's instructions.
- B. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer's instructions say otherwise.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Set flooring in place, press with heavy roller to attain full adhesion.
- E. Lay flooring with joints and seams parallel or as shown on plans to building lines to produce symmetrical tile pattern.
- F. Install tile to basket weave pattern. Allow minimum 1/2 full size tile width at room or area perimeter.
- G. Where floor finishes are different on opposite sides of door, terminate flooring under centerline of door.
- H. Scribe flooring to walls, columns, cabinets, and other appurtenances to produce tight joints.
- I. Install flooring in recessed floor access covers. Maintain floor pattern.

3.05 RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 48 inches between joints.
- B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.06 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's instructions.

- C. Clean, seal, and wax resilient flooring products in accordance with manufacturer's instructions.

3.07 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints and other coatings.
- C. Scope: Prepare and paint all interior new work and patching and all exterior lintels.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
- C. NACE (IMP) - Industrial Maintenance Painting; NACE International; Edition date unknown.
- D. SSPC (PM1) - Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings.

1.03 DEFINITIONS

- A. Conform to ASTM D 16 for interpretation of terms used in this section.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on all finishing products and special coatings, including VOC content.
- C. Samples: Submit two paper chip samples, 1 X 1 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.
- D. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on aluminum sheet, 6 x 6 inch in size.
- E. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.
- F. Certification: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.
- G. Manufacturer's Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.
- H. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum 5 years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years experience.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.08 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. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- D. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.09 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Supply 1 gallon of each color; store where directed.
- C. Label each container with color, type, texture, and room locations in addition to the manufacturer's label.

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. ICI Paints North America: www.icipaints.com
 - 2. Duron, Inc: www.duron.com.
 - 3. Sherwin Williams: www.sherwin-williams.com
 - 4. Benjamin Moore & Co: www.benjaminmoore.com.
 - 5. "Green Screen" paint:
 - a. Filmtools House Brand Chroma Key Green paint (non-reflective matte finish).
 - b. Rosco 5711 Chroma Key Green Video point.
- C. Field-Catalyzed Coatings:
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND COATINGS - GENERAL

- A. 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. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 - 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.

- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Chemical Content: The following compounds are prohibited:
 - 1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 - 2. Acrolein, acrylonitrile, antimony, benzene, butyl benzyl phthalate, cadmium, di (2-ethylhexyl) phthalate, di-n-butyl phthalate, di-n-octyl phthalate, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate, ethylbenzene, formaldehyde, hexavalent chromium, isophorone, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, naphthalene, toluene (methylbenzene), 1,1,1-trichloroethane, vinyl chloride.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Paint ME-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:
 - 1. One coat of alkyd primer.
 - 2. Semi-gloss: Two coats of alkyd enamel.

2.04 PAINT SYSTEMS - INTERIOR

- A. Paint WI-OP-3L - Wood, Opaque, Latex, 3 Coat:
 - 1. One coat of latex primer sealer.
- B. Paint CI-OP-3L - Concrete/Masonry, Opaque, Latex, 3 Coat:
 - 1. One coat of block filler.
 - 2. Egg Shell: Two coats of latex enamel.
- C. Paint MI-OP-2L - Ferrous Metals, Primed, Latex, 2 Coat:
 - 1. Touch-up with latex primer or manufacturer recommended.
 - 2. Flat: Two coats of latex enamel.
- D. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
 - 1. One coat of alkyd or latex primer sealer.
 - 2. Eggshell: Two coats of latex enamel.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.
- D. 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. Plaster and Stucco: 12 percent.
 - 3. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 5. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 6. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 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. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.
- E. Marks: Seal with shellac or stain blocker those which may bleed through surface finishes.
- 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. 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.
- H. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.
- I. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- J. Corroded Steel and Iron Surfaces to be Painted: Prepare using at least SSPC-PC 2 (hand tool cleaning) or SSPC-SP 3 (power tool cleaning) followed by SSPC-SP 1 (solvent cleaning).
- K. Uncorroded 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.
- L. Interior Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.03 APPLICATION

- A. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.
- B. Apply products in accordance with manufacturer's instructions.
- C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Apply each coat to uniform appearance.
- F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G. Sand wood and metal surfaces lightly between coats to achieve required finish.
- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- I. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finished coatings until completion of project.
- B. Touch-up damaged coatings after Substantial Completion.

END OF SECTION

SECTION 22 07 19
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 84 00 - Firestopping.
- C. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
- E. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- H. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- I. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- J. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
- K. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- L. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- M. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- N. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- O. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber.
- P. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- Q. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- R. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- S. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.

- T. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc..

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience, or and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER

- A. Manufacturers:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation; : www.certainteed.com.
 - 5. Substitutions: See Gilbane Project Manual.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 850 degrees F; 1200 degrees F; 1600 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 ; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 650 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Vapor Barrier Lap Adhesive:
 - 1. Compatible with insulation. Low VOC compliant (LEED).
- G. Insulating Cement/Mastic:
 - 1. ASTM C195; hydraulic setting on mineral wool.
- H. Fibrous Glass Fabric:

1. Cloth: Untreated; 9 oz/sq yd weight.
 2. Blanket: 1.0 lb/cu ft density.
 3. Weave: 5x5; 10x10; or 10x20.
- I. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd weight.
 2. Vinyl emulsion type acrylic, compatible with insulation, black or white color. Low VOC compliant (LEED).
- J. Insulating Cement:
1. ASTM C449/C449M. Low VOC compliant (LEED).

2.03 CELLULAR GLASS

- A. Manufacturers:
1. Pittsburgh Corning Corporation: www.foamglasinsulation.com.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C552, Grade 1.
1. 'K' value: 0.37 at 100 degrees F.
 2. Service Temperature: Up to 900 degrees F.
 3. Water Vapor Permeability: 0.005 perm inch.
 4. Water Absorption: 0.2 percent by volume, maximum.

2.04 EXPANDED POLYSTYRENE

- A. Manufacturers:
- B. Insulation: ASTM C578; rigid closed cell.
1. 'K' value: 0.23 at 75 degrees F.
 2. Maximum service temperature: 165 degrees F.
 3. Maximum water vapor permeance: 5.0 perms

2.05 EXPANDED PERLITE

- A. Manufacturers:
1. Schundler Company: www.schundler.com.
- B. Insulation: ASTM C610, molded.
1. Maximum service temperature: 1200 degrees F.
 2. Maximum water vapor transmission: 0.1 perm.

2.06 POLYISOCYANURATE CELLULAR PLASTIC

- A. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
1. Dimension: Comply with requirements of ASTM C585.
 2. 'K' value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
 3. Minimum Service Temperature: -70 degrees F.
 4. Maximum Service Temperature: 300 degrees F.
 5. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842..
 6. Moisture Vapor Transmission: 4.0 perm in.
 7. Connection: Waterproof vapor barrier adhesive. Low VOC compliant (LEED).

2.07 POLYETHYLENE

- A. Manufacturers:
1. Armacell LLC: www.armacell.us.
- B. Insulation: Flexible closed-cell polyethylene tubing, slit lengthwise for installation, complying with applicable requirements of ASTM D1056.
1. 'K' value: ASTM C177; 0.25 at 75 degrees F.

2. Maximum Service Temperature: 200 degrees F.
3. Density: 2 lb/cu ft.
4. Maximum Moisture Absorption: 1.0 percent by volume.
5. Moisture Vapor Permeability: 0.05 perm inch, when tested in accordance with ASTM E96/E96M.
6. Connection: Contact adhesive. Low VOC compliant (LEED).

2.08 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 1. Armacell LLC: www.armacell.us.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3; grade 2; grade 1 use molded tubular material wherever possible.
 1. Minimum Service Temperature: -40 degrees F.
 2. Maximum Service Temperature: 220 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Low VOC compliant (LEED).

2.09 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 1. Lagging Adhesive:
 - a. Compatible with insulation. Low VOC compliant (LEED).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H. Glass fiber insulated pipes conveying fluids above ambient temperature:
 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I. Inserts and Shields:
 1. Application: Piping 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert location: Between support shield and piping and under the finish jacket.
 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- M. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- N. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULES

3.04 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot, recirculated hot water and solar piping.
 1. Operating Temperature: 60 to 140 deg F.
 2. Insulation Material: Flexible elastomeric or glass fiber.
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, All Sizes: 1.0 inch.
 4. Jacket: None.
 5. Vapor Retarder Required: No.
 6. Finish: None.
- B. Service: Domestic cold water.
 1. Operating Temperature: 35 to 60 deg F.
 2. Insulation Material: Flexible elastomeric or glass fiber.
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 1" or less: 0.5 inch.
 - b. Pipe, 1¼" to 2" : 0.5 inch.
 4. Jacket: Foil and paper.
 5. Vapor Retarder Required: Yes.
 6. Finish: None.

END OF SECTION

SECTION 22 10 05
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, valves, and connections for piping systems.
 - 1. Domestic water.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 22 07 19 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; The American Society of Mechanical Engineers.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers.
- C. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers (ANSI B16.18).
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.
- F. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; The American Society of Mechanical Engineers.
- G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers.
- H. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers (ANSI/ASME B31.1).
- I. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers.
- J. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers (ANSI/ASME B31.9).
- K. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers.
- L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- M. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- N. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- O. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- P. ASTM B32 - Standard Specification for Solder Metal.
- Q. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
- R. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- S. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed.
- T. ASTM B75/B75M - Standard Specification for Seamless Copper Tube.
- U. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

- V. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- W. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.
- X. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
- Y. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
- Z. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.
- AA. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- AB. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- AC. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- AD. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- AE. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- AF. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- AG. NFPA 54 - National Fuel Gas Code; National Fire Protection Association.
- AH. NSF 61 - Drinking Water System Components - Health Effects.
- AI. NSF 372 - Drinking Water System Components - Lead Content.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Welder Qualifications: Certified in accordance with ASME (BPV IX).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - 3. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Grinnell Mechanical Products, a Tyco International Company; Model _____: www.grinnell.com.

- 2) Viega LLC; Model _____: www.viega.com.
- 3) Substitutions: See Section 01 60 00 - Product Requirements.

- B. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized, using one of the following joint types:
1. Threaded Joints: ASME B16.4 cast iron fittings.
 2. Grooved Joints: AWWA C606 grooved pipe, cast iron fittings, and mechanical couplings.

2.02 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 2. Joints: NFPA 54, threaded or welded to ASME B31.1.

2.03 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.
 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch:
1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
 2. Housing Material: Malleable iron or ductile iron, galvanized.
 3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 4. When pipe is field grooved, provide coupling manufacturer's grooving tools.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
- C. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 6. Other Types: As required.

2.05 GATE VALVES

- A. Manufacturers:

1. Conbraco Industries; Model _____: www.apollovalves.com.
 2. Nibco, Inc; Model _____: www.nibco.com.
 3. Milwaukee Valve Company; Model _____: www.milwaukeevalve.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 3 Inches:
1. MSS SP-80, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.
- C. 2 Inches and Larger:
1. MSS SP-70, Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.06 GLOBE VALVES

- A. Manufacturers:
1. Conbraco Industries; Model _____: www.apollovalves.com.
 2. Nibco, Inc; Model _____: www.nibco.com.
 3. Milwaukee Valve Company; Model _____: www.milwaukeevalve.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 3 Inches:
1. MSS SP-80, Class 125, bronze body, bronze trim, handwheel, bronze disc, solder ends.
- C. 2 Inches and Larger:
1. MSS SP-85, Class 125, iron body, bronze trim, handwheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.07 BALL VALVES

- A. Manufacturers:
1. Conbraco Industries; Model _____: www.apollovalves.com.
 2. Grinnell Mechanical Products, a Tyco International Company: www.grinnell.com.
 3. Nibco, Inc; Model _____: www.nibco.com.
 4. Milwaukee Valve Company; Model _____: www.milwaukeevalve.com.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, ductile iron, or _____ body, 304 stainless steel, chrome plated brass, or _____ ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder, threaded, grooved, or _____ ends with union.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 19.

- C. Install water piping to ASME B31.9.
- D. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.

3.04 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum hanger spacing: 6.5 ft.
 - 2) Hanger rod diameter: 3/8 inches.
 - b. Pipe size: 1-1/2 inches to 2 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 3/8 inch.

END OF SECTION

SECTION 23 05 13

MOTOR REQUIREMENTS FOR HVAC AND PLUMBING EQUIP

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.02 RELATED REQUIREMENTS

- A. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.
- B. Section 26 29 13 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc..
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers.
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- D. Operation Data: Include instructions for safe operating procedures.
- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
- B. Conform to applicable electrical code, NFPA 70 and local energy code.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of high efficiency motors.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

- A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Lincoln Motors: www.lincolnmotors.com.
- B. A. O. Smith Electrical Products Company: www.aosmithmotors.com.
- C. Reliance Electric/Rockwell Automation: www.reliance.com.
- D. Substitutions: See Gilbane Project Manual.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Section 26 27 17 for required electrical characteristics.
- B. Electrical Service, General. See drawings for specific details:
 - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
 - 2. Motors Larger than 1/2 Horsepower: 460 volts, three phase, 60 Hz.
- C. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 40 degrees C environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 4. Motors with frame sizes 254T and larger: Premium Efficiency Type.
- D. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- E. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor.
- F. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

2.03 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not conform to these specifications.
- B. Single phase motors for shaft mounted fans and centrifugal pumps: Split phase type.
- C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type or electronically commutated (ECM) type. See schedules for requirements.
- D. Single phase motors for fans, pumps, and blowers: Capacitor start type.
- E. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.
- F. Motors located in outdoors and in draw through cooling towers: Totally enclosed weatherproof epoxy-treated type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.
- D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

- E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 13.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- J. Sound Power Levels: To NEMA MG 1.
- K. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

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- L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- M. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- N. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.
- D. Provide detailed installation and purchase information for reimbursement by Utility for rebate program.

3.02 SCHEDULE - PREMIUM EFFICIENCY

- A. NEMA Open Motor Service Factors.
 - 1. 1/6-1/3 hp:
 - a. 3600 rpm: 1.35.
 - b. 1800 rpm: 1.35.
 - c. 1200 rpm: 1.35.
 - d. 900 rpm: 1.35.
 - 2. 1/2 hp:
 - a. 3600 rpm: 1.25.
 - b. 1800 rpm: 1.25.
 - c. 1200 rpm: 1.25.
 - d. 900 rpm: 1.15.
 - 3. 3/4 hp:
 - a. 3600 rpm: 1.25.
 - b. 1800 rpm: 1.25.
 - c. 1200 rpm: 1.15.
 - d. 900 rpm: 1.15.
 - 4. 1 hp:
 - a. 3600 rpm: 1.25.
 - b. 1800 rpm: 1.15.
 - c. 1200 rpm: 1.15.
 - d. 900 rpm: 1.15.
 - 5. 1.5-150 hp:
 - a. 3600 rpm: 1.15.
 - b. 1800 rpm: 1.15.
 - c. 1200 rpm: 1.15.
 - d. 900 rpm: 1.15.
- B. Three Phase - Premium Efficiency, Open Drip-Proof Performance:
 - 1. Ratings.
 - a. 1 hp:
 - 1) NEMA Frame: 145T.
 - 2) Minimum Percent Power Factor: 72.
 - 3) Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5% @ 1800 RPM, 77% @ 3600 RPM

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- b. 1-1/2 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 73.
 - 3) Minimum Percent Efficiency: 86.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84% @ 3600 RPM
- c. 2 hp:
 - 1) NEMA Frame: 184T.
 - 2) Minimum Percent Power Factor: 75.
 - 3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM
- d. 3 hp:
 - 1) NEMA Frame: 213T.
 - 2) Minimum Percent Power Factor: 60.
 - 3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 89.5% @ 1800 RPM, 85.5% @ 3600 RPM
- e. 5 hp:
 - 1) NEMA Frame: 215T.
 - 2) Minimum Percent Power Factor: 65.
 - 3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM
- f. 7-1/2 hp:
 - 1) NEMA Frame: 254T.
 - 2) Minimum Percent Power Factor: 73.
 - 3) Minimum Percent Efficiency: 90.2% @ 1200 RPM, 91% @ 1800 RPM, 88.5% @ 3600 RPM
- g. 10 hp:
 - 1) NEMA Frame: 256T.
 - 2) Minimum Percent Power Factor: 74.
 - 3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5% @ 3600 RPM
- h. 15 hp:
 - 1) NEMA Frame: 284T.
 - 2) Minimum Percent Power Factor: 77.
 - 3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 90.2% @ 3600 RPM.
- i. 20 hp:
 - 1) NEMA Frame: 286T.
 - 2) Minimum Percent Power Factor: 78.
 - 3) Minimum Percent Efficiency: 92.4% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM
- j. 25 hp:
 - 1) NEMA Frame: 324T.
 - 2) Minimum Percent Power Factor: 74.
 - 3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM
- k. 30 hp:
 - 1) NEMA Frame: 326T.
 - 2) Minimum Percent Power Factor: 78.
 - 3) Minimum Percent Efficiency: 93.6% @ 1200 RPM, 94.1% @ 1800 RPM, 91.7% @ 3600 RPM
- l. 40 hp:

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- 1) NEMA Frame: 364T.
- 2) Minimum Percent Power Factor: 77.
- 3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1 @ 1800 RPM, 92.4% @ 3600 RPM
- m. 50 hp:
 - 1) NEMA Frame: 365T.
 - 2) Minimum Percent Power Factor: 79.
 - 3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM
- C. Three Phase - Premium Efficiency, Totally Enclosed, Fan Cooled Performance:
 1. 1200 rpm.
 - a. 1 hp:
 - 1) NEMA Frame: 145T.
 - 2) Minimum Percent Power Factor: 72.
 - 3) Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5% @ 1800 RPM, 77% @ 3600 RPM
 - b. 1-1/2 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 73.
 - 3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84% @ 3600 RPM
 - c. 2 hp:
 - 1) NEMA Frame: 184T.
 - 2) Minimum Percent Power Factor: 68.
 - 3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM
 - d. 3 hp:
 - 1) NEMA Frame: 213T.
 - 2) Minimum Percent Power Factor: 63.
 - 3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM
 - e. 5 hp:
 - 1) NEMA Frame: 215T.
 - 2) Minimum Percent Power Factor: 66.
 - 3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 88.5% @ 3600 RPM
 - f. 7-1/2 hp:
 - 1) NEMA Frame: 254T.
 - 2) Minimum Percent Power Factor: 68.
 - 3) Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5% @ 3600 RPM
 - g. 10 hp:
 - 1) NEMA Frame: 256T.
 - 2) Minimum Percent Power Factor: 75.
 - 3) Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 90.2% @ 3600 RPM
 - h. 15 hp:
 - 1) NEMA Frame: 284T.
 - 2) Minimum Percent Power Factor: 72.
 - 3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 92.4% @ 1800 RPM, 91% @ 3600 RPM

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- i. 20 hp:
 - 1) NEMA Frame: 286T.
 - 2) Minimum Percent Power Factor: 76.
 - 3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM
- j. 25 hp:
 - 1) NEMA Frame: 324T.
 - 2) Minimum Percent Power Factor: 71.
 - 3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM
- k. 30 hp:
 - 1) NEMA Frame: 326T.
 - 2) Minimum Percent Power Factor: 79.
 - 3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM.
- l. 40 hp:
 - 1) NEMA Frame: 364T.
 - 2) Minimum Percent Power Factor: 78.
 - 3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1% @ 1800 RPM, 92.4% @ 3600 RPM
- m. 50 hp:
 - 1) NEMA Frame: 365T.
 - 2) Minimum Percent Power Factor: 81.
 - 3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM

END OF SECTION

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SECTION 23 05 16

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 23 00 - Refrigerant Piping.

1.03 REFERENCE STANDARDS

- A. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- B. EJMA (STDS) - EJMA Standards; Expansion Joint Manufacturers Association.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- C. Design Data: Indicate selection calculations.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- F. Maintenance Data: Include adjustment instructions.

1.05 REGULATORY REQUIREMENTS

- A. Conform to UL requirements.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturers:
 - 1. Mercer Rubber Company: www.mercer-rubber.com.
 - 2. Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Inner Hose: Carbon Steel.
- C. Exterior Sleeve: Single braided, stainless steel.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: Flanged.
- F. Size: Use pipe sized units.

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- G. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturer:
 - 1. Mercer Rubber Company: www.mercer-rubber.com.
 - 2. Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: Flanged.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.
- H. Application: Copper piping.

2.03 ACCESSORIES

- A. Stainless Steel Pipe: ASTM A269.
- B. Pipe Alignment Guides:
 - 1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION

SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gage taps.
- B. Thermometers and thermometer wells.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 09 23 - Direct-Digital Control System for HVAC.
- C. Section 23 09 93 - Sequence of Operations for HVAC Controls.

1.03 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers.
- B. ASTM E1 - Standard Specification for ASTM Thermometers.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Underwriters Laboratories Inc..

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Samples: Submit one of each type of instrument specified.
- D. Project Record Documents: Record actual locations of components and instrumentation.
- E. Operation and Maintenance Data: pressure gages, thermometers, static pressure gages.

1.05 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Moeller Instrument Co., Inc: www.moellerinstrument.com.
 - 3. Omega Engineering, Inc: www.omega.com.
- B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi and KPa.

2.02 PRESSURE GAGE TAPPINGS

- A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.

- B. Needle Valve: Brass or stainless steel 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- D. Syphon: Brass, Stainless Steel or Bronze 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Omega Engineering, Inc: www.omega.com.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
 - 1. Size: 7 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: 3/4 inch brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F and Degrees C.
- C. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 7 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F and Degrees C.

2.04 DIAL THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Omega Engineering, Inc: www.omega.com.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
 - 1. Size: 2 inch diameter dial.
 - 2. Lens: Clear Lexan.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F and Degrees C.
- C. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3 inch diameter dial.
 - 2. Lens: Clear Lexan.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F and Degrees C.
- D. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.

1. Size: 2-1/2 inch diameter dial.
2. Lens: Clear Lexan.
3. Length of Capillary: Minimum 5 feet.
4. Accuracy: 2 percent.
5. Calibration: Degrees F and Degrees C.

2.05 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.06 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
- B. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
- C. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Viton core for temperatures up to 400 degrees F.
- D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapters with 1/8 inch probes, two 1-1/2 inch dial thermometers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
- C. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 23 09 23. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- J. Locate test plugs adjacent thermometers and thermometer sockets, adjacent to pressure gages and pressure gage taps, adjacent to control device sockets and where indicated.

3.02 SCHEDULE

- A. Pressure Gages, Location and Scale Range:
 - 1. Pumps, 0 to 225 psi.
 - 2. Expansion tanks, 0 to 225 psi.
 - 3. Pressure tanks, 0 to 225 psi.
- B. Pressure Gage Tappings, Location:
 - 1. Control valves 3/4 inch & larger - inlets and outlets.
 - 2. Major coils - inlets and outlets.
 - 3. Chiller - inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Headers to central equipment, 0 to 220 degrees F.
 - 2. Coil banks - inlets and outlets, 0 to 220 degrees F.
 - 3. After major coils, 0 to 220 degrees F.
- D. Thermometer Sockets, Location:
 - 1. Control valves 1 inch & larger - inlets and outlets.

END OF SECTION

SECTION 23 05 48

VIBRATION AND SEISMIC CON. FOR HVAC AND PLUMB, PIPING AND EQUIP.

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment support bases.
- B. Vibration isolators.
- C. Inertia bases.
- D. Vibration isolators.
- E. Seismic restraints.

1.02 SUBMITTALS

- A. Product Data: Provide schedule of vibration isolator type with location and load on each.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.
- C. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Isolation Technology, Inc: www.isolationtech.com.
- B. Kinetics Noise Control, Inc: www.kineticsnoise.com.
- C. Mason Industries: www.mason-ind.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. General:
 - 1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
 - 2. Steel springs to function without undue stress or overloading.

2.03 EQUIPMENT SUPPORT BASES

2.04 VIBRATION ISOLATORS

2.05 INERTIA BASES

- A. Structural Bases:
 - 1. Construction: Welded structural steel with gusseted brackets, to support equipment and motor, with motor slide rails.
 - 2. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
- B. Concrete Inertia Bases:
 - 1. Construction: Structural steel channel perimeter frame, with gusseted brackets and anchor bolts, reinforcing; concrete filled.
 - 2. Mass: Minimum of 1.5 times weight of isolated equipment.
 - 3. Connecting Point: Reinforced to connect isolators and snubbers to base.
 - 4. Concrete: Minimum 3000 psi concrete.

2.06 VIBRATION ISOLATORS

- A. Open Spring Isolators:

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1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
- B. Restrained Open Spring Isolators:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 4. Restraint: Provide heavy mounting frame and limit stops.
 5. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
- C. Closed Spring Isolators:
1. Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
 4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
- D. Restrained Closed Spring Isolators:
1. Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
 4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
- E. Spring Hangers:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
 3. Misalignment: Capable of 20 degree hanger rod misalignment.
 4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
- F. Neoprene Pad Isolators:

1. Rubber or neoprene waffle pads.
 - a. Hardness: 30 durometer.
 - b. Thickness: Minimum 1/2 inch.
 - c. Maximum Loading: 50 psi.
 - d. Rib Height: Maximum 0.7 times width.
2. Configuration: Single layer.
3. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.
- G. Rubber Mount or Hanger: Molded rubber designed for 0.4 inch deflection with threaded insert.
- H. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.
- I. Seismic Snubbers:
 1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
 2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
 3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
 4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.
- J. Roof Mounting Curb: 14 inches high with rigid steel lower section containing adjustable spring pockets with restrained spring isolators, steel upper section to support rooftop equipment, and continuous elastomeric membrane extending from upper section for counterflashing over roofing. Provide acoustical package consisting of interior perimeter angles and cross members to support up to two layers of gypsum board.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Bases:
 1. Set steel bases for one inch clearance between housekeeping pad and base.
 2. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
 3. Adjust equipment level.
- C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- E. Provide pairs of horizontal limit springs on fans with more than 6.0 inches WC static pressure, and on hanger supported, horizontally mounted axial fans.
- F. Provide seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 0.05 inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.
- G. Support piping connections to equipment mounted on isolators using isolators or resilient hangers as follows:
 1. Up to 4 Inches Pipe Size: First three points of support.
 2. 5 to 8 Inches Pipe Size: First four points of support.
 3. 10 inches Pipe Size and Over: First six points of support.
 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.02 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.03 SCHEDULE

- A. Pipe Isolation Schedule.
 - 1. 1 Inch Pipe Size: Isolate 120 diameters from equipment.
 - 2. 2 Inch Pipe Size: Isolate 90 diameters from equipment.
 - 3. 3 Inch Pipe Size: Isolate 80 diameters from equipment.
 - 4. 4 Inch Pipe Size: Isolate 75 diameters from equipment.
 - 5. 6 Inch Pipe Size: Isolate 60 diameters from equipment.
 - 6. 8 Inch Pipe Size: Isolate 60 diameters from equipment.
 - 7. 10 Inch Pipe Size: Isolate 54 diameters from equipment.
 - 8. 12 Inch Pipe Size: Isolate 50 diameters from equipment.
 - 9. 16 Inch Pipe Size: Isolate 45 diameters from equipment.
 - 10. 24 Inch Pipe Size: Isolate 38 diameters from equipment.
 - 11. Over 24 Inch Pipe Size: As indicated.
- B. Equipment Isolation Schedule.
 - 1. HVAC Pumps.
 - a. Base: Concrete inertia base.
 - b. Isolator Type: Open Spring Isolators

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.02 RELATED REQUIREMENTS

- A. Section 09 90 00 - Painting and Coating: Identification painting.

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Samples: Submit two labels, tags and pipe markers.
- F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- G. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Brady Corporation: www.bradycorp.com.
- B. Champion America, Inc: www.Champion-America.com.
- C. Seton Identification Products: www.seton.com/aec.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Green.

2.03 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved white letters on green contrasting background color. Tag size minimum 1-1/2 inch diameter.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
 6. Ductwork and Equipment: 2-1/2 inch high letters.
- B. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors conforming to ASME A13.1.

2.05 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.06 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 1. HVAC Equipment: Yellow.
 2. Fire Dampers and Smoke Dampers: Red.
 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 09 90 00.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- H. Identify control panels and major control components outside panels with plastic nameplates.

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- I. Identify thermostats relating to terminal boxes or valves with nameplates.
- J. Identify valves in main and branch piping with tags.
- K. Identify air terminal units and radiator valves with numbered tags.
- L. Tag automatic controls, instruments, and relays. Key to control schematic.
- M. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet 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.
- N. Identify ductwork with plastic nameplates or stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- O. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.03 UNIT TAG SCHEDULE

- A. Equipment Type: Variable - Air Volume Units (VAV)
 - 1. Identification: Tag (VAV-X) where X = VAV number. Include Flow Rates (GPM and Max/Min CFM)
 - 2. Background:
 - a. Size: As needed to contain information
 - b. Color: Yellow
 - 3. Lettering:
 - a. Size: 1/4 inch high
 - b. Color: Black
 - 4. Placement: As directed by Architect/Engineer
- B. Equipment Type: Rooftop Mounted Air Handling Unit (RTU)
 - 1. Identification: Tag (RTU-X) where X = Unit number. Include manufacturer, model number, serial number, date of manufacturer start-up, date of manufacture, refrigerant type (if applicable), voltage, frequency, phase
 - 2. Background:
 - a. Size: As needed to contain information
 - b. Color: Yellow
 - 3. Lettering:
 - a. Size: 1/4 inch high
 - b. Color: Black
 - 4. Placement: As directed by Architect/Engineer
- C. Equipment Type: Pumps (P)
 - 1. Identification: Tag (P-X) where X = Pump number. Include manufacturer, model number, serial number, date of manufacturer start-up, date of manufacture, voltage, frequency, phase, GPM, Design Head Pressure (FT H₂O)
 - 2. Background:
 - a. Size: As needed to contain information
 - b. Color: Yellow
 - 3. Lettering:
 - a. Size: 1/4 inch high
 - b. Color: White
 - 4. Placement: As directed by Architect/Engineer

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating as applicable systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Sound measurement of equipment operating conditions.
- E. Vibration measurement of equipment operating conditions.
- F. Commissioning activities.

1.02 RELATED REQUIREMENTS

- A. Section 23 08 00 - Commissioning of HVAC.

1.03 REFERENCE STANDARDS

- A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council.
- B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc..
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to the Commissioning Authority.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - 4. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.

- g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - h. Expected problems and solutions, etc.
 - i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
 - j. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - n. Method of checking building static and exhaust fan and/or relief damper capacity.
 - o. Proposed selection points for sound measurements and sound measurement methods.
 - p. Methods for making coil or other system plant capacity measurements, if specified.
 - q. Time schedule for TAB work to be done in phases (by floor, etc.).
 - r. Description of TAB work for areas to be built out later, if any.
 - s. Time schedule for deferred or seasonal TAB work, if specified.
 - t. False loading of systems to complete TAB work, if specified.
 - u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - v. Interstitial cavity differential pressure measurements and calculations, if specified.
 - w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - x. Procedures for formal progress reports, including scope and frequency.
 - y. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to Studio JAED; Commissioning Authority and HVAC Controls Contractor.
- E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- F. Progress Reports.
- G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Submit to the Commissioning Authority; Studio JAED and HVAC Controls Contractor within two weeks after completion of testing, adjusting, and balancing.
 - 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.

4. Provide reports in hard cover letter size 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 7. Units of Measure: Report data in I-P (inch-pound) units only.
 8. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Engineer.
 - g. Project altitude.
 - h. Report date.
- H. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 1. AABC MN-1, AABC National Standards for Total System Balance.
 2. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 3. SMACNA HVAC Systems Testing, Adjusting, and Balancing.
 4. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Having minimum of three years documented experience.
 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org.
- E. TAB Supervisor Qualifications: Professional Engineer licensed in the State in which the Project is located.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.

- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

- A. See Section 23 08 00 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 20 percent of the air handlers plus a random sample equivalent to 20 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 - 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
 - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 - 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all

balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.09 SCOPE

- A. Test, adjust, and balance the following:
 - 1. HVAC Pumps
 - 2. Packaged Roof Top Heating/Cooling Units
 - 3. Air Coils
 - 4. Fans
 - 5. Air Terminal Units
 - 6. Air Inlets and Outlets
 - 7. Fume Hoods and associated Fans (ALTERNATE #1)

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer
 - 2. Model/Frame
 - 3. HP/BHP
 - 4. Phase, voltage, amperage; nameplate, actual, no load
 - 5. RPM
 - 6. Service factor
 - 7. Starter size, rating, heater elements
 - 8. Sheave Make/Size/Bore
- B. V-Belt Drives:
 - 1. Identification/location
 - 2. Required driven RPM
 - 3. Driven sheave, diameter and RPM
 - 4. Belt, size and quantity
 - 5. Motor sheave diameter and RPM
 - 6. Center to center distance, maximum, minimum, and actual
- C. Pumps:
 - 1. Identification/number
 - 2. Manufacturer
 - 3. Size/model
 - 4. Impeller
 - 5. Service
 - 6. Design flow rate, pressure drop, BHP
 - 7. Actual flow rate, pressure drop, BHP
 - 8. Discharge pressure
 - 9. Suction pressure
 - 10. Total operating head pressure
 - 11. Shut off, discharge and suction pressures
 - 12. Shut off, total head pressure
- D. Cooling Coils:
 - 1. Identification/number
 - 2. Location
 - 3. Service
 - 4. Manufacturer
 - 5. Air flow, design and actual
 - 6. Entering air DB temperature, design and actual
 - 7. Entering air WB temperature, design and actual

8. Leaving air DB temperature, design and actual
9. Leaving air WB temperature, design and actual
10. Water flow, design and actual
11. Saturated suction temperature, design and actual
12. Air pressure drop, design and actual
- E. Heating Coils:
 1. Identification/number
 2. Location
 3. Service
 4. Manufacturer
 5. Air flow, design and actual
 6. Water flow, design and actual
 7. Water pressure drop, design and actual
 8. Entering water temperature, design and actual
 9. Leaving water temperature, design and actual
 10. Entering air temperature, design and actual
 11. Leaving air temperature, design and actual
 12. Air pressure drop, design and actual
- F. Air Moving Equipment:
 1. Location
 2. Manufacturer
 3. Model number
 4. Serial number
 5. Arrangement/Class/Discharge
 6. Air flow, specified and actual
 7. Return air flow, specified and actual
 8. Outside air flow, specified and actual
 9. Total static pressure (total external), specified and actual
 10. Inlet pressure
 11. Discharge pressure
 12. Sheave Make/Size/Bore
 13. Number of Belts/Make/Size
 14. Fan RPM
- G. Return Air/Outside Air:
 1. Identification/location
 2. Design air flow
 3. Actual air flow
 4. Design return air flow
 5. Actual return air flow
 6. Design outside air flow
 7. Actual outside air flow
 8. Return air temperature
 9. Outside air temperature
 10. Required mixed air temperature
 11. Actual mixed air temperature
 12. Design outside/return air ratio
 13. Actual outside/return air ratio
- H. Duct Traverses:
 1. System zone/branch
 2. Duct size

3. Area
4. Design velocity
5. Design air flow
6. Test velocity
7. Test air flow
8. Duct static pressure
9. Air temperature
10. Air correction factor
- I. Duct Leak Tests:
 1. Description of ductwork under test
 2. Duct design operating pressure
 3. Duct design test static pressure
 4. Duct capacity, air flow
 5. Maximum allowable leakage duct capacity times leak factor
 6. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Calibrated
 7. Test static pressure
 8. Test orifice differential pressure
 9. Leakage
- J. Air Monitoring Stations:
 1. Identification/location
 2. System
 3. Size
 4. Area
 5. Design velocity
 6. Design air flow
 7. Test velocity
 8. Test air flow
- K. Flow Measuring Stations:
 1. Identification/number
 2. Location
 3. Size
 4. Manufacturer
 5. Model number
 6. Serial number
 7. Design Flow rate
 8. Design pressure drop
 9. Actual/final pressure drop
 10. Actual/final flow rate
 11. Station calibrated setting
- L. Terminal Unit Data:
 1. Manufacturer
 2. Type, constant, variable, single, dual duct
 3. Identification/number
 4. Location
 5. Model number
 6. Size

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7. Minimum static pressure
 8. Minimum design air flow
 9. Maximum design air flow
 10. Maximum actual air flow
 11. Inlet static pressure
- M. Air Distribution Tests:
1. Air terminal number
 2. Room number/location
 3. Terminal type
 4. Terminal size
 5. Area factor
 6. Design velocity
 7. Design air flow
 8. Test (final) velocity
 9. Test (final) air flow
 10. Percent of design air flow
- N. Sound Level Reports:
1. Location
 2. Octave bands - equipment off
 3. Octave bands - equipment on
- O. Vibration Tests:
1. Location of points:
 - a. Fan bearing, drive end
 - b. Fan bearing, opposite end
 - c. Motor bearing, center (if applicable)
 - d. Motor bearing, drive end
 - e. Motor bearing, opposite end
 - f. Casing (bottom or top)
 - g. Casing (side)
 - h. Duct after flexible connection (discharge)
 - i. Duct after flexible connection (suction)
 2. Test readings:
 - a. Horizontal, velocity and displacement
 - b. Vertical, velocity and displacement
 - c. Axial, velocity and displacement
 3. Normally acceptable readings, velocity and acceleration
 4. Unusual conditions at time of test
 5. Vibration source (if non-complying)

END OF SECTION

SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Insulation jackets.

1.02 RELATED REQUIREMENTS

- A. Section 09 90 00 - Painting and Coating: Painting insulation jackets.
- B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- C. Section 23 31 00 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- D. ASTM C553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- J. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.
- K. SMACNA (DCS) - HVAC Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association.
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc..

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation: www.certainteed.com.
 - 5. Substitutions: See Gilbane Building Company.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- F. Tie Wire: Annealed steel, 16 gage.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation: www.certainteed.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum service temperature: 450 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent.

4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 2. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Indoor Vapor Barrier Finish:
 1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 1. Lagging Adhesive:
 - a. Compatible with insulation.
- B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.
- C. Aluminum Jacket: ASTM B209 (ASTM B209M).
 1. Thickness: 0.016 inch sheet.
 2. Finish: Smooth.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
 6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated ducts conveying air below ambient temperature:
 1. Provide insulation with vapor barrier jackets.
 2. Finish with tape and vapor barrier jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated ducts conveying air above ambient temperature:
 1. Provide with or without standard vapor barrier jacket.
 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces : Finish with canvas jacket sized for finish painting.
- F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.

- G. External Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 2. Secure insulation without vapor barrier with staples, tape, or wires.
 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- H. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

A. INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

1. Service: Round, supply-air ducts, concealed.
 - a. Material: Mineral-fiber blanket.
 - b. Thickness: 1-1/2 inches.
 - c. Jacket: Foil and paper.
 - d. Vapor Retarder Required: Yes.
2. Service: Round, return-air ducts, concealed.
 - a. Material: Mineral-fiber blanket.
 - b. Thickness: 1 inch.
 - c. Jacket: Foil and paper.
 - d. Vapor Retarder Required: Yes.
3. Service: Round, outside-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 1-1/2 inches.
 - c. Jacket: Foil and paper.
 - d. Vapor Retarder Required: Yes.
4. Service: Rectangular, supply-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 1-1/2 inches.
 - c. Jacket: Foil and paper.
 - d. Vapor Retarder Required: Yes.
5. Service: Rectangular, return-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 1 inch.
 - c. Jacket: Foil and paper.
 - d. Vapor Retarder Required: Yes.
6. Service: Rectangular, outside-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 1- 1/2 inches.
 - c. Jacket: Foil and paper.
 - d. Vapor Retarder Required: Yes.
7. Service: Round, supply-air ducts, exposed.

- a. Material: Mineral-fiber blanket
 - b. Thickness: 2 inches.
 - c. Jacket: Aluminum, painted to architects specifications.
 - d. Vapor Retarder Required: Yes.
8. Service: Round, return-air ducts, exposed.
- a. Material: Mineral-fiber board.
 - b. Thickness: 1 inch.
 - c. Jacket: Aluminum, painted to architects specifications.
 - d. Vapor Retarder Required: No.
 - e. NOTE: Provide double-walled spiral ductwork in areas noted on drawings as defined in specification section 15890.
9. Service: Round, outside-air ducts, exposed.
- a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Jacket: Aluminum, painted to architects specifications.
 - d. Vapor Retarder Required: Yes.
 - e. NOTE: Provide double-walled spiral ductwork in areas noted on drawings as defined in specification section 15890.
10. Service: Rectangular, supply-air ducts, exposed.
- a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Jacket: Aluminum, painted to architects specifications.
 - d. Vapor Retarder Required: Yes.
11. Service: Rectangular, return-air ducts, exposed.
- a. Material: Mineral-fiber board.
 - b. Thickness: 1 inch.
 - c. Jacket: Aluminum, painted to architects specifications
 - d. Vapor Retarder Required: No.
12. Service: Rectangular, outside-air ducts, exposed.
- a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Jacket: Aluminum, painted to architects specifications.
 - d. Vapor Retarder Required: Yes.
13. Service: Rectangular, range-hood exhaust ducts, concealed.
- a. Material: Calcium silicate.
 - b. Thickness: 2 inches.
 - c. Field-Applied Jacket: Glass cloth.
 - d. Vapor Retarder Required: No.
14. Service: Rectangular, range-hood exhaust ducts, exposed.
- a. Material: Calcium silicate.
 - b. Thickness: 2 inches.
 - c. Field Applied Jacket: Stainless steel.
 - d. Vapor Retarder Required: No.
15. Service: Rectangular, dishwasher exhaust ducts, concealed.
- a. Material: Mineral-fiber blanket.
 - b. Thickness: 1/2 inch.
 - c. Jacket: Foil and Paper
 - d. Vapor Retarder Required: No.
16. Service: Rectangular, dishwasher exhaust ducts, exposed.
- a. Material: Mineral-fiber board.
 - b. Thickness: 1/2 inch.

- c. Jacket: Aluminum
- d. Vapor Retarder Required: No.

B. OUTDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- 1. Service: Round, supply-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch
 - d. Vapor Retarder Required: Yes.
- 2. Service: Round, return-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch
 - d. Vapor Retarder Required: Yes.
- 3. Service: Rectangular, supply-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch
 - d. Vapor Retarder Required: Yes.
- 4. Service: Rectangular, return-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch
 - d. Vapor Retarder Required: Yes.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 09 90 00 - Painting and Coating: Painting insulation jacket.
- C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
- D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
- E. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- H. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- I. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- J. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- K. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
- L. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- M. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- N. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- O. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
- P. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- Q. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber.
- R. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

- T. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- U. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.
- V. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc..

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER

- A. Manufacturers:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation: www.certainteed.com.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 850 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 650 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

- F. Vapor Barrier Lap Adhesive:
 - 1. Compatible with insulation.
- G. Insulating Cement/Mastic:
 - 1. ASTM C195; hydraulic setting on mineral wool.
- H. Fibrous Glass Fabric:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Blanket: 1.0 lb/cu ft density.
 - 3. Weave: 5x5.
- I. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.
- J. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- K. Outdoor Breather Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- L. Insulating Cement:
 - 1. ASTM C449/C449M.

2.03 CELLULAR GLASS

- A. Manufacturers:
 - 1. Pittsburgh Corning Corporation: www.foamglasinsulation.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C552, Grade 1.
 - 1. 'K' value: 0.37 at 100 degrees F.
 - 2. Service Temperature: Up to 900 degrees F.
 - 3. Water Vapor Permeability: 0.005 perm inch.
 - 4. Water Absorption: 0.2 percent by volume, maximum.

2.04 EXPANDED POLYSTYRENE

- A. Insulation: ASTM C578; rigid closed cell.
 - 1. 'K' value: 0.23 at 75 degrees F.
 - 2. Maximum service temperature: 165 degrees F.
 - 3. Maximum water vapor permeance: 5.0 perms

2.05 EXPANDED PERLITE

- A. Manufacturers:
 - 1. Schundler Company: www.schundler.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C610, molded.
 - 1. Maximum service temperature: 1200 degrees F.
 - 2. Maximum water vapor transmission: 0.1 perm.

2.06 HYDROUS CALCIUM SILICATE

- A. Manufacturers:
 - 1. Johns Manville Corporation: www.jm.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
 - 1. 'K' value: ASTM C177 and C518; 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum service temperature: 1200 degrees F.

- 3. Density: 15 lb/cu ft.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Insulating Cement:
 - 1. ASTM C449/C449M.

2.07 POLYISOCYANURATE CELLULAR PLASTIC

- A. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
 - 1. Dimension: Comply with requirements of ASTM C585.
 - 2. 'K' value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
 - 3. Minimum Service Temperature: -70 degrees F.
 - 4. Maximum Service Temperature: 300 degrees F.
 - 5. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842..
 - 6. Moisture Vapor Transmission: 4.0 perm in.
 - 7. Connection: Waterproof vapor barrier adhesive.

2.08 POLYETHYLENE

- A. Manufacturers:
 - 1. Armacell LLC; Model _____: www.armacell.us.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Flexible closed-cell polyethylene tubing, slit lengthwise for installation, complying with applicable requirements of ASTM D1056.
 - 1. 'K' value: ASTM C177; 0.25 at 75 degrees F.
 - 2. Maximum Service Temperature: 300 degrees F.
 - 3. Density: 2 lb/cu ft.
 - 4. Maximum Moisture Absorption: 1.0 percent by volume.
 - 5. Moisture Vapor Permeability: 0.05 perm inch, when tested in accordance with ASTM E96/E96M.
 - 6. Connection: Contact adhesive.

2.09 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell LLC; _____: www.armacell.us.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: -40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.10 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.

- d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
- 3. Covering Adhesive Mastic:
 - a. Compatible with insulation.
- B. ABS Plastic:
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: -40 degrees F.
 - b. Maximum Service Temperature of 180 degrees F.
 - c. Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 30 mil.
 - e. Connections: Brush on welding adhesive.
- C. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive:
 - a. Compatible with insulation.
- D. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.
- E. Stainless Steel Jacket: ASTM A666, Type 302 stainless steel.
 - 1. Thickness: 0.010 inch.
 - 2. Finish: Smooth.
 - 3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

- G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.
- M. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- N. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULE

- A. PIPING INSULATION SCHEDULES
 - 1. General: Abbreviations used in the following schedules include:
 - a. Field Applied Jackets: P - PVC, K-Foil and Paper, A - Aluminum, SS - Stainless Steel.
 - b. Piping Sizes: NPS - Nominal Pipe Size.
- B. INTERIOR PIPING APPLICATION SCHEDULE
 - 1. Service: Condensate drain piping.
 - a. Operating Temperature: 35 to 75 deg F.
 - b. Insulation Material: Flexible elastomeric.
 - c. Insulation Thickness: 0.5 inch.
 - d. Jacket: None.
 - e. Vapor Retarder Required: Yes.
 - f. Finish: None.
- C. Service: Heating hot-water supply and return.
 - 1. Operating Temperature: 100 to 250 deg F.
 - 2. Insulation Material: Mineral fiber or glass fiber.

3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 1" or less: 1.0 inch.
 - b. Pipe, 1-1/4" to 4": 1.5 inch.
 - c. Pipe, 5" and up: 2.0 inch.
 4. Jacket: PVC.
 5. Vapor Retarder Required: No.
 6. Finish: None.
- D. EXTERIOR PIPING INSULATION APPLICATION SCHEDULE
- E. This application schedule is for aboveground insulation outside the building. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.
- F. Service: Heating hot-water supply and return.
1. Operating Temperature: 100 to 250 deg F.
 2. Insulation Material: Mineral fiber
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, Any pipe size: 2.0 inch.
 4. Field-Applied Jacket: Aluminum.
 5. Vapor Retarder Required: No.
 6. Finish: None.

END OF SECTION

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air supply system.
- B. Thermostats/Temp sensors.
- C. Humidistats.
- D. Control valves.
- E. Automatic dampers.
- F. Damper operators.
- G. Time clocks.
- H. Miscellaneous accessories.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Section 23 05 19 - Meters and Gages for HVAC Piping.
- C. Section 23 21 13 - Hydronic Piping.
- D. Section 23 33 00 - Air Duct Accessories.
- E. Section 23 09 23 - Direct-Digital Control System for HVAC.
- F. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- G. Section 26 27 26 - Wiring Devices.
- H. Section 26 27 17 - Equipment Wiring.

1.03 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods for Testing Dampers for Rating; Air Movement and Control Association International, Inc..
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.
- C. ASTM B32 - Standard Specification for Solder Metal.
- D. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- E. ASTM B819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems.
- F. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- G. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats; National Electrical Manufacturers Association.
- H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.

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- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Manufacturer's Instructions: Provide for all manufactured components.
- E. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials:
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience approved by manufacturer.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 PRE-INSTALLATION MEETING

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

1.08 WARRANTY

- A. See Section 01 78 13 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 1 Year period after Substantial Completion.

1.09 MAINTENANCE SERVICE

- A. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- B. Provide complete service of controls systems, including call backs. Make minimum of 5 complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

1.10 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Provide two of each type of thermostat and exposed sensor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Johnson Controls.

- B. Substitutions: Not permitted.

2.02 EQUIPMENT - GENERAL

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

2.03 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enamelled finished face panel.
- C. Provide common keying for all panels.

2.04 CONTROL VALVES

- A. Globe Pattern:
1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel or brass.
 - c. Size for 3 psig maximum pressure drop at design flow rate.
 - d. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
- B. Butterfly Pattern:
1. Iron body, bronze; aluminum bronze, or stainless steel disc, resilient replaceable seat for service to 250 degrees F wafer or lug ends, extended neck.
 2. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Size for 1 psig maximum pressure drop at design flow rate.
- C. Electronic Operators:
1. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 2. Select operator for full shut off at maximum pump differential pressure.
 3. Product:
- D. Radiation Valves:
1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
 2. Rate for service pressure of 125 psig at 250 degrees F.
 3. Size for 3 psig maximum pressure drop at design flow rate.
 4. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
 5. Operators (2 Position): Synchronous motor with enclosed gear train, dual return springs, valve position indicator; 24 v DC, 0.4 amp. Valves shall spring return to normal position for temperature protection.
 6. Operators (Modulating): Self contained, linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel with transformer and SPDT contacts: 24 v DC, 6 watt maximum input.

2.05 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Extruded aluminum; welded or riveted with corner reinforcement, minimum 12 gage.
- C. Blades: Extruded aluminum; maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, attached to minimum 1/2 inch shafts with set screws.
- D. Blade Seals: Synthetic elastomeric or Neoprene mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Shaft Bearings: Oil impregnated sintered bronze.
- G. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
- H. Leakage: Less than one percent based on approach velocity of 2000 ft/min and 4 inches wg.
- I. Maximum Pressure Differential: 6 inches wg.
- J. Temperature Limits: -40 to 200 degrees F.
- K. Product:
 - 1. Ruskin
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.06 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - 2. Provide one operator for maximum 36 sq ft damper section.
- B. Pilot Positioners: Starting point adjustable from 2 to 12 psig and operating span adjustable from 5 to 13 psig.
- C. Electric Operators:
 - 1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch and minimum position potentiometer.
- D. Inlet Vane Operators:
 - 1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.

2.07 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
 - 2. Measuring current maximum 5 mA with maximum self-heat of 0.031 degrees F/mW in fluids and 0.014 degrees F/mW in air.
 - 3. Provide 3 lead wires and shield for input bridge circuit.
 - 4. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 8 feet or 16 feet as required.
 - 5. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches.
 - 6. Room sensors: Johnson 9100 series or equal.
 - 7. Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.

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8. Room security sensors: Stainless steel cover plate with insulated back and security screws. Application in hallways, gymnasiums, and other high-impact areas.
- B. Humidity Sensors:
 1. Elements: Accurate within 5 percent full range with linear output.
 2. Room Sensors: With locking cover, span of 30 to 80 percent relative humidity.
 3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.
- C. Static Pressure Sensors:
 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 4. Output: 0 - 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation Sensors:
 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
 2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. Digital to Pneumatic Transducers:
 1. Convert continuous proportional current or voltage to 0 to 20 psi.
- F. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.
- G. Carbon Dioxide Level Sensors (CO₂):
 1. Wall or duct-mounted as required by control sequence or plans.
 2. Demand-control ventilation sensor for measuring and transmitting CO₂ levels ranging from 0-2,000 ppm.
 3. Single-beam, dual-wavelength design with five-year stability for calibration..
 4. Proportional output, 4-20 mA signal.

2.08 THERMOSTATS

- A. Electric Room Thermostats:
 1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
 2. Service: cooling and heating.
 3. Covers: Locking.
 4. Covers: Locking with set point adjustment, set point indication.
- B. Line Voltage Thermostats:
 1. Integral manual On/Off/Auto selector switch, single or two pole as required.
 2. Dead band: Maximum 2 degrees F.
 3. Cover: Locking with set point adjustment, set point indication.
 4. Rating: Motor load.
- C. Room Thermostat Accessories:
 1. Insulating Bases: For thermostats located on exterior walls.
 2. Thermostat Guards: Locking transparent plastic mounted on separate base.
 3. Adjusting Key: As required for device.
 4. Aspirating Boxes: Where indicated for thermostats requiring flush installation.
- D. Outdoor Reset Thermostat:

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1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
2. Scale range: -10 to 100 degrees F.
- E. Immersion Thermostat:
 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- F. Airstream Thermostats:
 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 2. Averaging service remote bulb element: 7.5 feet.
- G. Electric Low Limit Duct Thermostat:
 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,
 2. Bulb length: Minimum 20 feet.
 3. Provide one thermostat for every 20 sq ft of coil surface.
- H. Electric High Limit Duct Thermostat:
 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,
 2. Bulb length: Minimum 20 feet.
 3. Provide one thermostat for every 20 sq ft of coil surface.
- I. Fire Thermostats:
 1. UL labeled, factory set in accordance with NFPA 90A.
 2. Normally closed contacts, manual reset.
- J. Heating/Cooling Valve Top Thermostats:
 1. Proportional acting for proportional flow, molded rubber diaphragm, remote bulb liquid filled element, direct and reverse acting at differential pressure to 25 psig, cast housing with position indicator and adjusting knob.

2.09 TRANSMITTERS

- A. Building Static Pressure Transmitter:
 1. One pipe, differential type with temperature compensation, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.
- B. Pressure Transmitters:
 1. One pipe direct acting for gas, liquid, or steam service, range suitable for system, proportional electronic output.
- C. Temperature Transmitters:
 1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degree F span and plus or minus 1 percent for 50 degree F span, with 200 degrees F temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.
- D. Humidity Transmitters:
 1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.

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- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats. Refer to Section 26 27 26.
- C. Mount freeze protection thermostats using flanges and element holders.
- D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements.
- F. Provide fht-plate temperative sensors in all high-abuse areas (gymnasiums, halls, cafeteria, etc.)
- G. Provide guards on thermostats in entrances and public areas.
- H. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- I. Provide separate steam valves for each bank of coils. Provide two valves in parallel where steam load exceeds 1500 lb/hr with 1/3 - 2/3 load capacities sequenced with smaller valve opening first.
- J. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors.
- K. Provide isolation (two position) dampers of parallel blade construction.
- L. Provide pilot positioners on pneumatic damper operators sequenced with other controls.
- M. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- N. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- O. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- P. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MAINTENANCE

- A. Provide service and maintenance of control system for one year from Date of Substantial Completion.

- B. Provide complete service of controls systems, including call backs, and submit written report of each service call.

END OF SECTION

SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. System Description
- B. Operator Interface
- C. Controllers
- D. Power Supplies and Line Filtering
- E. System Software
- F. Controller Software
- G. HVAC Control Programs
- H. Control equipment.
- I. Software.

1.02 RELATED REQUIREMENTS

- A. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- B. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- C. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SYSTEM DESCRIPTION

- A. The ATC System shall be one of BACnet MS/TP direct digital controls
- B. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to Building Management System, fully accessible via fully secured web-assessible internet portal as manufactured by Johnson Controls utilizing electric actuation. A minimum of one (1) Network Automation Engine (NAE) shall be installed as a web-based extension to the existing Metasys network for LES. Any N2 bus ASC devices remaining after the renovation will be mapped into the new NAE and appear seamless with the new BACnet MS/TP devices to the Owner's operators. A Metasys "companion" or NCM-based system is unacceptable.
- C. The existing pneumatic control system for components to remain (those not in the scope of renovations, such as exhaust fans, radiant heat, and existing H&V units to remain) is to remain operational. Ensure that the pneumatic equipment that is demolished is properly terminated to maintain the integrity of the pneumatic system.
- D. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- E. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- F. Controls for RTUs, VAV boxes, exhaust fans, ventilators, make up air units, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- G. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to

operate mechanical systems, and to perform functions specified. All sensor locations in rooms, piping, and ductwork shall be confirmed with the engineer prior to installation.

- H. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- I. Include installation of power wiring for all controllers and control transformers as required to complete the work.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List connected data points, including connected control unit and input device.
 - 3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
 - 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 5. Indicate description and sequence of operation of operating, user, and application software.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
- F. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 10 years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section minimum 10 years documented experience approved by manufacturer.
- E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.07 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this Section.
- B. Require attendance of parties directly affecting the work of this Section.

1.08 WARRANTY

- A. See Section 01 77 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.09 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
- B. Provide four complete inspections per year, two in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- C. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

1.10 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Provide two toner cartridges.

1.11 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Johnson Controls, Inc: www.johnsoncontrols.com.
- B. Substitutions: Not Permitted.

2.02 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units .
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.03 OPERATOR INTERFACE

- A. PC Based Work Station:
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. Hardware:

2.04 CONTROLLERS

- A. BUILDING CONTROLLERS
 - 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. INPUT/OUTPUT INTERFACE

1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.05 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 2. Limit connected loads to 80 percent of rated capacity.
 3. Match DC power supply to current output and voltage requirements.

4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 7. Operational Ambient Conditions: 32 to 120 degrees F.
 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
 9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.06 OPERATOR STATION

- A. Work Station:
1. Not required. Tie into existing campus-wide BAS network.

2.07 CONTROL UNITS

- A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.
- B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.
- C. Control Units Functions:
1. Monitor or control each input/output point.
 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 3. Acquire, process, and transfer information to operator station or other control units on network.
 4. Accept, process, and execute commands from other control unit's or devices or operator stations.
 5. Access both data base and control functions simultaneously.
 6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
 7. Perform in stand-alone mode:
 - a. Start/stop.
 - b. Duty cycling.
 - c. Automatic Temperature Control.
 - d. Demand control via a sliding window, predictive algorithm.
 - e. Event initiated control.
 - f. Calculated point.
 - g. Scanning and alarm processing.
 - h. Full direct digital control.
 - i. Trend logging.
 - j. Global communications.
 - k. Maintenance scheduling.
- D. Global Communications:

1. Broadcast point data onto network, making that information available to all other system control units.
 2. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.
- E. Input/Output Capability:
1. Discrete/digital input (contact status).
 2. Discrete/digital output.
 3. Analog input.
 4. Analog output.
 5. Pulse input (5 pulses/second).
 6. Pulse output (0-655 seconds in duration with 0.01 second resolution).
- F. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Install control unit's with minimum 30 percent spare capacity.
- G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
- H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.
- I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from work station.
 2. Control output points but change only data base state or value; leave external field hardware unchanged.
 3. Enable control actions on output points but change only data base state or value.
- J. Local display and adjustment panel: Portable control unit, containing digital display, and numerical keyboard. Display and adjust:
1. Input/output point information and status.
 2. Controller set points.
 3. Controller tuning constants.
 4. Program execution times.
 5. High and low limit values.
 6. Limit differential.
 7. Set/display date and time.
 8. Control outputs connected to the network.
 9. Automatic control outputs.
 10. Perform control unit diagnostic testing.
 11. Points in "Test" mode.

2.08 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.09 SYSTEM SOFTWARE

- A. Operating System:
 - 1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems: _____.
 - 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
 - 3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
 - 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - b. Ancillary Equipment:
- B. Workstation System Applications:
 - 1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 - 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 - 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 - 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.

5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
14. Reports:
 - a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.

- 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- C. Workstation Applications Editors:
1. Provide editing software for all system applications at the PC workstation.
 2. Downloaded application is executed at controller panel.
 3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
 4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
 5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.10 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.

2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
1. Binary object is set to alarm based on the operator specified state.
 2. Analog object to have high/low alarm limits.
 3. All alarming is capable of being automatically and manually disabled.
 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.
- H. PID Control Characteristics:
1. Direct or reverse action.
 2. Anti-windup.
 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:
1. Prevents all controlled equipment from simultaneously restarting after power outage.
 2. Order of equipment startup is user selectable.
- J. Energy Calculations:
1. Accumulated instantaneous power or flow rates are converted to energy use data.
 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- K. Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
 2. Allows minimum on-time and off-time to be selected.
- L. On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- M. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
 2. Provides operator with capability to assign high run-time alarm.

2.11 OPERATING SYSTEM SOFTWARE

- A. Input/Output Capability From Operator Station:
 - 1. Request display of current values or status in tabular or graphic format.
 - 2. Command selected equipment to specified state.
 - 3. Initiate logs and reports.
 - 4. Change analog limits.
 - 5. Add, delete, or change points within each control unit or application routine.
 - 6. Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.
 - 7. Add new control units to system.
 - 8. Modify and set up maintenance scheduling parameters.
 - 9. Develop, modify, delete or display full range of color graphic displays.
 - 10. Automatically archive select data even when running third party software.
 - 11. Provide capability to sort and extract data from archived files and to generate custom reports.
 - 12. Support two printer operations.
 - a. Alarm printer: Print alarms, operator acknowledgements, action messages, system alarms, operator sign-on and sign-off.
 - b. Data printer: Print reports, page prints, and data base prints.
 - 13. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
 - 14. Print selected control unit data base.
- B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.
- C. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match. Minimum capability shall include:
 - 1. Add and delete points.
 - 2. Modify any point parameter.
 - 3. Change, add, or delete English language descriptors.
 - 4. Add, modify, or delete alarm limits.
 - 5. Add, modify, or delete points in start/stop programs, trend logs, etc.
 - 6. Create custom relationship between points.
 - 7. Create or modify DDC loops and parameters.
 - 8. Create or modify override parameters.
 - 9. Add, modify, and delete any applications program.
 - 10. Add, delete, develop, or modify dynamic color graphic displays.
- D. Dynamic Color Graphic Displays:
 - 1. Utilizes custom symbols or system supported library of symbols.
 - 2. Sixteen (16) colors.
 - 3. Sixty (60) outputs of real time, live dynamic data per graphic.
 - 4. Dynamic graphic data.
 - 5. 1,000 separate graphic pages.
 - 6. Modify graphic screen refresh rate between 1 and 60 seconds.
- E. Operator Station:
 - 1. Accept data from LAN as needed without scanning entire network for updated point data.
 - 2. Interrogate LAN for updated point data when requested.
 - 3. Allow operator command of devices.
 - 4. Allow operator to place specific control units in or out of service.

5. Allow parameter editing of control units.
 6. Store duplicate data base for every control unit and allow down loading while system is on line.
 7. Control or modify specific programs.
 8. Develop, store and modify dynamic color graphics.
 9. Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.
- F. Alarm Processing:
1. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state/value and which alarms shall cause automatic dial-out.
 2. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
 3. Print on line changeable message, up to 100 characters in length, for each alarm point specified.
 4. Display alarm reports on video. Display multiple alarms in order of occurrence.
 5. Define time delay for equipment start-up or shutdown.
 6. Allow unique routing of specific alarms.
 7. Operator specifies if alarm requires acknowledgement.
 8. Continue to indicate unacknowledged alarms after return to normal.
 9. Alarm notification:
 - a. Automatic print.
 - b. Display indicating alarm condition.
 - c. Selectable audible alarm indication.
- G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.
- H. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.
- I. Messages:
1. Automatically display or print user-defined message subsequent to occurrence of selected events.
 2. Compose, change, or delete any message.
 3. Display or log any message at any time.
 4. Assign any message to any event.
- J. Reports:
1. Manually requested with time and date.
 2. Long term data archiving to hard disk.
 3. Automatic directives to download to transportable media such as floppy diskettes for storage.
 4. Data selection methods to include data base search and manipulation.
 5. Data extraction with mathematical manipulation.
 6. Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
 7. Generating reports either normally at operator direction, or automatically under work station direction.
 8. Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.

9. Include capability for statistical data manipulation and extraction.
 10. Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- L. Data Collection:
1. Automatically collect and store in disk files.
 2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2 year period.
 3. Daily consumption for up to 30 meters over a 2 year period.
 4. Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.
 5. Provide archiving of stored data for use with system supplied custom reports.
- M. Graphic Display: Support graphic development on work station with software features:
1. Page linking.
 2. Generate, store, and retrieve library symbols.
 3. Single or double height characters.
 4. Sixty (60) dynamic points of data per graphic page.
 5. Pixel level resolution.
 6. Animated graphics for discrete points.
 7. Analog bar graphs.
 8. Display real time value of each input or output line diagram fashion.
- N. Maintenance Management:
1. Run time monitoring, per point.
 2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
 3. Equipment safety targets.
 4. Display of maintenance material and estimated labor.
 5. Target point reset, per point.
- O. Advisories:
1. Summary which contains status of points in locked out condition.
 2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
 3. Report of power failure detection, time and date.
 4. Report of communication failure with operator device, field interface unit, point, programmable control unit.

2.12 LOAD CONTROL PROGRAMS

- A. General: Support inch-pounds and SI (metric) units of measurement.
- B. Demand Limiting:
1. Monitor total power consumption per power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
 2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
 3. Forecast demand (kW): Predicted by sliding window method.
 4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
 5. Demand Target: Minimum of 3 per demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
 6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
 7. Limits: Include control band (upper and lower limits).

8. Output advisory if loads are not available to satisfy required shed amount, advise shed requirements and requiring operator acknowledgement.
- C. Duty Cycling:
 1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
 2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by same amount that off portion is reduced.
 3. Set and modify following parameters for each individual load.
 - a. Minimum and maximum Off time.
 - b. On/Off time in one minute increments.
 - c. Time period from beginning of interval until load can be cycled.
 - d. Manually override the DCC program and place a load in an On or Off state.
 - e. Cooling Target Temperature and Differential.
 - f. Heating Target Temperature and Differential.
 - g. Cycle off adjustment.
- D. Automatic Time Scheduling:
 1. Self-contained programs for automatic start/stop/scheduling of building loads.
 2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
 3. Special days schedule shall support up to 30 unique date/duration combinations.
 4. Any number of loads assigned to any time program; each load can have individual time program.
 5. Each load assigned at least 16 control actions per day with 1 minute resolution.
 6. Time schedule operations may be:
 - a. Start.
 - b. Optimized Start.
 - c. Stop.
 - d. Optimized Stop.
 - e. Cycle.
 - f. Optimized Cycle.
 7. Minimum of 30 holiday periods up to 100 days in length may be specified for the year.
 8. Create temporary schedules.
 9. Broadcast temporary "special day" date and duration.
- E. Start/Stop Time Optimization:
 1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
 2. Adaptive and self-tuning, adjusting to changing conditions unattended.
 3. For each point under control, establish and modify:
 - a. Occupancy period.
 - b. Desired temperature at beginning of occupancy period.
 - c. Desired temperature at end of occupancy period.
- F. Night Setback/Setup Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- G. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
 1. Employ arithmetic, algebraic, Boolean, and special function operations.
 2. Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.
- H. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.

1. Define time interval between each control action between 0 to 3600 seconds.
 2. Output may be analog value.
 3. Provide for "skip" logic.
 4. Verify completion of one action before proceeding to next. If not verified, program shall be able to skip to next action.
- I. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
1. Control loops: Defined using "modules" that are analogous to standard control devices.
 2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
 3. Firmware:
 - a. PID with analog or pulse-width modulation output.
 - b. Floating control with pulse-width modulated outputs.
 - c. Two-position control.
 - d. Primary and secondary reset schedule selector.
 - e. Hi/Lo signal selector.
 - f. Single pole double throw relay.
 - g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
 4. Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, program shall execute user defined failsafe output.
 5. Display: Value or state of each of the lines which interconnect DDC modules.
- J. Fine Tuning Direct Digital Control PID or floating loops:
1. Display information:
 - a. Control loop being tuned
 - b. Input (process) variable
 - c. Output (control) variable
 - d. Setpoint of loop
 - e. Proportional band
 - f. Integral (reset) Interval
 - g. Derivative (rate) Interval
 2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" vs "variable".
- K. Trend logging:
1. Each control unit will store samples of control unit's data points.
 2. Update file continuously at discretely assignable intervals.
 3. Automatically initiate upload request and then store data on hard disk.
 4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
 5. Co-ordinate sampling with on/off state of specified point.
 6. Display trend samples on work station in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time vs data.

2.13 HVAC CONTROL PROGRAMS

- A. General:
1. Support Inch-pounds and SI (metric) units of measurement.
 2. Identify each HVAC Control system.
- B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.

2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 4. Use outside air temperature to determine early shut down with ventilation override.
 5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
 6. Operator commands:
 - a. Define term schedule
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run time control summary.
 - i. Request optimal run time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.
 7. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run time system normal start times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
 8. Mass temperature summary:
 - a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.
 9. HVAC point summary:
 - a. Control system identifier and status.
 - b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and point.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
 2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.
 - b. Reducing heating temperatures to lowest possible level.
 3. Operator commands:

- a. Add/delete fan status point.
- b. Lock/unlock program.
- c. Request HVAC point summary.
- d. Add/Delete discharge controller point.
- e. Define discharge controller parameters.
- f. Add/delete air flow rate.
- g. Define space load and load parameters.
- h. Request space load summary.
- 4. Control summary:
 - a. HVAC control system status (begin/end).
 - b. Supply air reset system status.
 - c. Optimal run time system status.
 - d. Heating and cooling loop.
 - e. High/low limits.
 - f. Deadband.
 - g. Response timer.
 - h. Reset times.
- 5. Space load summary:
 - a. HVAC system status.
 - b. Optimal run time status.
 - c. Heating/cooling loop status.
 - d. Space load point ID.
 - e. Current space load point value.
 - f. Control heat/cool limited.
 - g. Gain factor.
 - h. Calculated reset values.
 - i. Fan status point ID and status.
 - j. Control discharge temperature point ID and status.
 - k. Space load point ID and status.
 - l. Air flow rate point ID and status.
- D. Enthalpy Switchover:
 - 1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
 - 2. Operator commands:
 - a. Add/delete fan status point.
 - b. Add/delete outside air temperature point.
 - c. Add/delete discharge controller point.
 - d. Define discharge controller parameters.
 - e. Add/delete return air temperature point.
 - f. Add/delete outside air dew point/humidity point.
 - g. Add/delete return air dew point/humidity point.
 - h. Add/delete damper switch.
 - i. Add/delete minimum outside air.
 - j. Add/delete atmospheric pressure.
 - k. Add/delete heating override switch.
 - l. Add/delete evaporative cooling switch.
 - m. Add/delete air flow rate.
 - n. Define enthalpy deadband.
 - o. Lock/unlock program.
 - p. Request control summary.
 - q. Request HVAC point summary.

3. Control summary:
 - a. HVAC control system begin/end status.
 - b. Enthalpy switchover optimal system status.
 - c. Optimal return time system status.
 - d. Current outside air enthalpy.
 - e. Calculated mixed air enthalpy.
 - f. Calculated cooling coil enthalpy using outside air.
 - g. Calculated cooling coil enthalpy using mixed air.
 - h. Calculated enthalpy difference.
 - i. Enthalpy switchover deadband.
 - j. Status of damper mode switch.

2.14 PROGRAMMING APPLICATION FEATURES

- A. Trend Point:
 1. Sample up to 150 points, real or computed, with each point capable of collecting 100 samples at intervals specified in minutes, hours, days, or month.
 2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern or color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.
- B. Alarm Messages:
 1. Allow definition of minimum of 100 messages, each having minimum length of 100 characters for each individual message.
 2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.
 3. Output assigned alarm with "message requiring acknowledgement".
 4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.
- C. Weekly Scheduling:
 1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.
 2. Provide program times for each day of week, per point, with one minute resolution.
 3. Automatically generate alarm output for points not responding to command.
 4. Provide for holidays, minimum of 366 consecutive holidays.
 5. Operator commands:
 - a. System logs and summaries.
 - b. Start or stop point.
 - c. Lock or unlock control or alarm input.
 - d. Add, delete, or modify analog limits and differentials.
 - e. Adjust point operation position.
 - f. Change point operational mode.
 - g. Open or close point.
 - h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
 - i. Begin or end point totalization.
 - j. Modify totalization values and limits.
 - k. Access or secure point.
 - l. Begin or end HVAC or load control system.
 - m. Modify load parameter.
 - n. Modify demand limiting and duty cycle targets.
 6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

- D. Interlocking:
 - 1. Permit events to occur, based on changing condition of one or more associated master points.
 - 2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.
 - 3. Operator commands:
 - a. Define single master/multiple master interlock process.
 - b. Define logic interlock process.
 - c. Lock/unlock program.
 - d. Enable/disable interlock process.
 - e. Execute terminate interlock process.
 - f. Request interlock type summary.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.
- C. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C. Provide basic operator training for 10 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Cecil County Public Schools.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. Radiation and convectors.
 - 2. Packaged Air Handling Units, including Variable Air Volume Terminals

1.02 RELATED SECTIONS

- A. Section 23 09 23 - Direct-Digital Control System for HVAC.
- B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- C. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
 - 1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
 - 2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in the contract documents.
 - 3. Include at least the following sequences:
 - a. Start-up.
 - b. Warm-up mode.
 - c. Normal operating mode.
 - d. Unoccupied mode.
 - e. Shutdown.
 - f. Capacity control sequences and equipment staging.
 - g. Temperature and pressure control, such as setbacks, setups, resets, etc.
 - h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - i. Effects of power or equipment failure with all standby component functions.
 - j. Sequences for all alarms and emergency shut downs.
 - k. Seasonal operational differences and recommendations.
 - l. Interactions and interlocks with other systems.
 - 4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - 5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls

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- and the control system, indicating which points are adjustable control points and which points are only monitored.
6. Include schedules, if known.
- C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
1. Label with settings, adjustable range of control and limits.
 2. Include flow diagrams for each control system, graphically depicting control logic.
 3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 5. Include all monitoring, control and virtual points specified in elsewhere.
 6. Include a key to all abbreviations.
- D. Points List: Submit list of all control points indicating at least the following for each point.
1. Name of controlled system.
 2. Point abbreviation.
 3. Point description; such as dry bulb temperature, airflow, etc.
 4. Display unit.
 5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
 6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
 7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
 8. Calculated point (Yes / No); i.e. a "virtual" point generated from calculations of other point values.
- E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.05 QUALITY ASSURANCE

- A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL SYSTEM DESIGN AND OPERATION STANDARDS

- A. The new BAS shall control the mechanical systems within the the facility based upon a central heating plant with a hydronic distribution system serving rooftop-mounted air handling units and variable-air volume terminals throughout the facility. Boiler/burner systems shall be controlled via local fire-control units.
- B. Hot water hydronic distribution system shall be part of a 2-pipe variable-flow system with two-way control valves mounted at each unit.
- C. Each air handling unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to a space temperature sensor, discharge air temperature sensor, return air temperature sensor, damper motors, control valve, and a serpentine freeze stat. Units shall include occupied/unoccupied control, night-setback, morning warm-up/cool-down, and enthalpy-based economizer functions.

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3.02 HEATING WATER SYSTEM

- A. General
 - 1. The heating water system shall be manually enabled and disabled from the operator workstation.

3.03 FINNED-TUBE RADIATION AND CONVECTORS

- A. Single temperature thermostat set at 70 degrees F maintains constant space temperature during the day and 15 degrees F cooler at night by modulating two-way control heating valve with spring range of 3 to 7 psig.

3.04 VARIABLE AIR VOLUME AIR HANDLING UNIT WITH DX COOLING, HOT GAS REHEAT, HOT WATER HEAT, AND VAV TERMINAL UNITS

- A. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to the required air temperature sensors noted in paragraph "G" below, damper motors, control valve, duct static pressure sensor, energy recovery wheel, outdoor airflow monitoring station, and condensing unit control relays. Each VAV terminal unit shall also be provided with its own controller that shall be wired to a space temperature sensor, control valve, and damper actuator.
- B. Sequence of operation:
 - 1. Cooling Mode: Cooling mode shall be selected based on outdoor air temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously with the outside air damper open to the minimum position as defined by the outdoor airflow monitoring station CFM value. Unless economizer mode is engaged, the outdoor air damper shall modulate in response to the outdoor airflow monitoring station to maintain the minimum required airflow as defined by the drawing schedule. The variable frequency drive shall modulate the supply and return fans to maintain a given static pressure within the ductwork (0.25" wc, adjustable). The compressor(s) and hot-gas bypass system shall modulate to maintain a discharge air temperature of 55 degrees (adjustable). On a rise in space temperature above the setpoint (75 degrees, adjustable), the associated VAV terminal unit shall modulate open to allow greater airflow to meet the space setpoint. If the space temperature continues to rise more than 4 degrees (adjustable) above the setpoint, an alarm shall be generated at the workstation terminal noting "High Space Temperature." On a fall in space temperature the reverse shall occur. On a continued fall in more than one space temperature associated with the unit of more than 5 degrees (adjustable) below the setpoint the unit shall reset the discharge air to provide a 65 degree (adjustable) discharge air temperature. If the temperature space temperature continues to fall an alarm shall be generated at the workstation terminal noting "Low Space Temperature".
 - a. For units equipped with an outdoor air economizer: The DDC Controller shall receive input from the Enthalpy Sensor. If the enthalpy of the outdoor air is lower than the defined minimum level (user adjustable) the mixing box economizer sequence shall be activated upon a call for cooling. The outside air damper shall never close past the minimum position called for by the outdoor airflow monitoring station during the occupied period.
 - b. When dehumidification is required as sensed by the factory-provided humidistat (setpoint, 60% RH, adjustable), the hot-gas reheat system will be engaged and follow the factory-programmed sequence.
 - 2. Heating Mode: Heating mode shall be selected based on outdoor air temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously with the outside air damper open to the minimum position as defined by the outdoor airflow monitoring station CFM value. Unless economizer mode is engaged, the outdoor air damper shall modulate in response to the

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outdoor airflow monitoring station to maintain the minimum required airflow as defined by the drawing schedule. The variable frequency drive shall modulate the supply and return fans to maintain a given static pressure within the ductwork (0.25" wc, adjustable). The hot water control valve in the primary heating coil shall modulate to maintain a discharge air setpoint of 55 degrees (adjustable). The VAV terminal unit modulating air damper shall be in its minimum position. On a fall in space temperature below the setpoint (68 degrees, adjustable), the associated VAV terminal unit shall modulate the associated hot water coil towards the open position. On a continued fall in space temperature of more than 4 degrees (adjustable) below setpoint, an alarm shall be generated at the workstation terminal noting "Low Space Temperature". On a rise in space temperature, the reverse shall occur. On a continued rise in space temperature, an alarm shall be generated at the workstation noting "High Space Temperature".

- a. The factory-provided sequence of operation shall provide frost-protection for the energy recovery wheel via modulation of wheel rotation speed, damper actuation, and control valve operation.
3. Unoccupied Mode: During the programmed un-occupied mode, the fan, compressor, hot water valves, and mixing box dampers shall be cycled / modulated to maintain the un-occupied setpoints (80 degrees cooling, 60 degrees heating, adjustable). The VAV boxes shall be opened to their maximum position in unoccupied cooling mode, and minimum position in unoccupied heating mode. Unless required for economizer cycle, the outside air damper shall remain closed. The VAV boxes shall be opened to their maximum position in unoccupied mode.
- C. Provide a current sensor on one phase of power feeding the supply fan, and compressor(s) for status indication at the Operator's Terminal.
- D. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating; a low temperature alarm shall be activated at the Operator's Terminal. If the discharge temperature fails to fall to a programmed minimum temperature on a call for mechanical cooling, a high temperature alarm shall be activated at the Operator's Terminal.
- E. A serpentine freeze stat shall be furnished, installed and wired in the unit by the BAS contractor. When tripped, the freeze stat shall function to de-energize the supply fan, mixing box damper actuators, and hot water control valve. When de-energized, the mixing box damper actuators shall spring return the outside and relief air dampers closed, the hot water or dual temperature water control valve shall spring return open to the coil, the freeze-protection pump associated with the unit shall be energized, and the isolation valve to the freeze-protection pump shall be opened (see detail on drawings). When the freeze stat trips, an alarm shall be generated at the Operator's Terminal.
- F. A duct smoke detector shall be furnished, installed and wired to the fire alarm system as required by the electrical contractor. The duct smoke detector shall be provided with an auxiliary alarm contact which will be used by the BAS Contractor to de-energize the supply fan, mixing box damper actuators, chilled water, hot water control valve. When de-energized, the mixing box damper actuators shall spring return the outside and relief air dampers closed, and an alarm shall be generated at the Operator's Terminal.
- G. The following items shall be displayed at the Operator's Terminal:
 1. Space temperature for each VAV unit.
 2. Space temperature setpoint for each VAV unit.
 3. Commanded position of each VAV damper.
 4. Commanded position of each VAV control valve.
 5. Outdoor Airflow Monitoring station flowrate reading
 6. Low Space temperature alarm
 7. High Space temperature alarm
 8. AHU Discharge temperature.

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9. AHU Return air temperature.
10. AHU Mixed Air Temperature
11. Outside air temperature, humidity and enthalpy.
12. Fan operational status via current sensor.
13. Energy recovery wheel status via current sensor.
14. Commanded status of fan.
15. Commanded status of compressor(s).
16. Commanded status of hot-water valve(s).
17. Commanded position of dampers.
18. Commanded status of energy recovery wheel.
19. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

3.05 EXHAUST FANS

- A. Exhaust Fans Serving Toilet Rooms or Locker Rooms
 1. Exhaust fans shall be scheduled for occupied and unoccupied cycles based on an operator adjustable time schedule. Fans may also be manually enabled and disabled at the operator workstation. Fan status shall be monitored by the BAS via the sensors capable of sensitivity adjustment.
 2. For single-use toilet rooms, exhaust fans shall be controlled via wall-switch.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Pipe and pipe fittings for:
 - 1. Heating water piping system.
 - 2. Equipment drains and overflows.
- D. Pipe hangers and supports.
- E. Unions, flanges, mechanical couplings, and dielectric connections.
- F. Valves:
 - 1. Gate valves.
 - 2. Globe or angle valves.
 - 3. Ball valves.
 - 4. Plug valves.
 - 5. Butterfly valves.
 - 6. Check valves.
- G. Flow controls.

1.02 RELATED REQUIREMENTS

- A. Section 09 90 00 - Painting and Coating.
- B. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
- C. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- D. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- E. Section 23 07 19 - HVAC Piping Insulation.
- F. Section 23 21 14 - Hydronic Specialties.
- G. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers.
- C. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers (ANSI B16.18).
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- F. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- G. ASME B31.9 - Building Services Piping (ANSI/ASME B31.9).
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.
- I. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers.

- J. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers (ANSI/ASME B31.9).
- K. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- L. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
- M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- N. ASTM B32 - Standard Specification for Solder Metal.
- O. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- P. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- Q. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- R. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- S. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- T. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- U. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- V. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- W. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
- X. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society.
- Y. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- Z. AWWA C606 - Grooved and Shouldered Joints (ANSI/AWWA C606).
- AA. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..

1.04 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- C. Use non-conducting dielectric connections whenever jointing dissimilar metals.
- D. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
- E. Use gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- F. Use globe or butterfly valves for throttling, bypass, or manual flow control services.
- G. Use 3/4 inch gate or ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders certification of compliance with ASME (BPV IX).
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Project Record Documents: Record actual locations of valves.
- F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 3 years of experience.
- C. Welder Qualifications: Certify in accordance with ASME (BPV IX).

1.07 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever joining dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
 - b. Grooved mechanical connections and joints comply with AWWA C606.
 - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
 - 2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
 - c. Use rigid joints unless otherwise indicated.

- d. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - e. Provide steel coupling nuts and bolts complying with ASTM A183.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated and as follows:
 - 1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
 - 4. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.
 - 5. For throttling service, use plug cocks. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

2.02 HEATING WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1 welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 - 3. Fittings: ASTM B 16.3, malleable iron or ASTM A 234/A 234M, wrought steel welding type fittings.
 - 4. Joints: Threaded, or AWS D1.1 welded.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.
 - 2. Viega Pro-Press pipe joining systems
 - a. System selected for proper application and temperature range of heating-water piping system.
 - 3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 - 4. Joints: Solder, lead free, 95-5 tin-antimony, or tin and silver.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
 - 3. Joints: Solder, lead free, ASTM B 32, HB alloy (95-5 tin-antimony), or tin and silver.
- B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
 - 1. Fittings: ASTM D2466 or D2467, PVC.

2. Joints: Solvent welded in accordance with ASTM D2855.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Conform to ASME B31.9.
- C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
- D. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
- E. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- F. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
- G. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- H. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
- I. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- J. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- K. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
- L. Vertical Support: Steel riser clamp.
- M. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- N. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- O. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- P. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- Q. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- R. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Under:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe Over 2 Inches:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick preformed neoprene.
- C. Grooved and Shouldered Pipe End Couplings:
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Clamps: Malleable iron galvanized to engage and lock, designed to permit some angular deflection, contraction, and expansion.
 - 4. Gasket Material: EPDM suitable for operating temperature range from -30 degrees F to 230 degrees F.

5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.06 GATE VALVES

- A. Manufacturers:
1. Conbraco Industries: www.conbraco.com.
 2. Nibco, Inc: www.nibco.com.
 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 2 Inches:
1. Bronze body, bronze trim, screwed bonnet, non-rising stem, lockshield stem, inside screw with backseating stem, solid wedge disc, alloy seat rings, solder or threaded ends.
- C. Over 2 Inches:
1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

2.07 GLOBE OR ANGLE VALVES

- A. Manufacturers:
1. Conbraco Industries: www.conbraco.com.
 2. Nibco, Inc: www.nibco.com.
 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 2 Inches:
1. Bronze body, bronze trim, screwed bonnet, rising stem and handwheel, inside screw with backseating stem, renewable composition disc and bronze seat, solder or threaded ends.
- C. Over 2 Inches:
1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.

2.08 BALL VALVES

- A. Manufacturers:
1. Conbraco Industries: www.conbraco.com.
 2. Nibco, Inc: www.nibco.com.
 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 2 Inches:
1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
- C. Over 2 Inches:
1. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged.

2.09 PLUG VALVES

- A. Manufacturers:
1. Conbraco Industries: www.conbraco.com.
 2. Nibco, Inc: www.nibco.com.
 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze tapered plug, 40 percent port opening, non-lubricated, teflon packing, threaded ends.
 - 2. Operator: One plug valve wrench for every ten plug valves minimum of one.
- C. Over 2 Inches:
 - 1. Cast iron body and plug, 40 percent port opening, pressure lubricated, teflon packing, flanged ends.
 - 2. Operator: Each plug valve with a wrench with set screw.

2.10 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Crane Co.: www.cranevalve.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, grooved, or _____ ends, extended neck.
- C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, Buna-N encapsulation, or _____.
- D. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- E. Disc: Aluminum bronze.
- F. Operator: Infinite position lever handle with memory stop.

2.11 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
- C. Over 2 Inches:
 - 1. Iron body, bronze or _____ trim, stainless steel, bronze, bronze faced rotating, or _____ swing disc, renewable disc and seat, flanged, grooved, or _____ ends.
 - 2. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.12 SPRING LOADED CHECK VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Crane Co.: www.cranevalve.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

2.13 FLOW CONTROLS

- A. Manufacturers:
 - 1. Tour and Anderson: www.touranderson.com.
 - 2. ITT Bell & Gossett: www.bellgossett.com.
 - 3. Griswold Controls: www.griswoldcontrols.com.
 - 4. Taco, Inc: www.taco-hvac.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.
- D. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements. Install chilled water piping to ASME B31.5 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls and floors.
- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
- I. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- J. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9.
 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 3. Place hangers within 12 inches of each horizontal elbow.
 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Provide copper plated hangers and supports for copper piping.
 8. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- L. Provide access where valves and fittings are not exposed.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- N. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 90 00.
- O. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.
 7. 6 inch: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 8. 8 inch: Maximum span, 16 feet; minimum rod size, 5/8 inch.
 9. 10 inch: Maximum span, 18 feet; minimum rod size, 3/4 inch.
 10. 12 inch: Maximum span, 19 feet; minimum rod size, 7/8 inch.
- B. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
 11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.
 12. 14 inches: Maximum span, 25 feet; minimum rod size, 1 inch.
 13. 16 inches: Maximum span, 27 feet; minimum rod size, 1 inch.
 14. 18 inches: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.

15. 20 inches: Maximum span, 30 feet; minimum rod size, 1-1/4 inch.
- C. Hanger Spacing for Plastic Piping.
 1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
 2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
 3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
 4. 1-1/4 inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
 5. 1-1/2 inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
 6. 2 inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.
 7. 3 inches: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 8. 4 inches: Maximum span, 8 feet; minimum rod size, 1/2 inch.
 9. 6 inches: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 10. 8 inches: Maximum span, 11 feet; minimum rod size, 5/8 inch.
 11. 10 inches: Maximum span, 13 feet; minimum rod size, 3/4 inch.
 12. 12 inches: Maximum span, 14 feet; minimum rod size, 7/8 inch.
 13. 14 inches: Maximum span, 15 feet; minimum rod size, 1 inch.
 14. 16 inches: Maximum span, 16 feet; minimum rod size, 1 inch.
 15. 18 inches: Maximum span, 18 feet; minimum rod size, 1-1/4 inch.

END OF SECTION

SECTION 23 21 14
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air vents.
- B. Strainers.
- C. Suction diffusers.
- D. Combination pump discharge valves.
- E. Combination flow controls.
- F. Pump suction fittings.
- G. Combination fittings.
- H. Flow indicators and controls.
- I. Relief valves.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 25 00 - HVAC Water Treatment: Pipe Cleaning.

1.03 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Project Record Documents: Record actual locations of flow controls.
- F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com.
 - 2. ITT Bell & Gossett: www.bellgossett.com.
 - 3. Taco, Inc: www.taco-hvac.com.

- 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 - 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.
- D. Washer Type:
 - 1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.02 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com.
 - 2. Green Country Filtration: greencountryfiltration.com.
 - 3. WEAMCO: www.weamco.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Size 2 inch and Under:
 - 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
 - 1. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
 - 1. Flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.03 SUCTION DIFFUSERS

- A. Manufacturers:
 - 1. ITT Bell & Gossett: www.bellgossett.com.
 - 2. Anvil International, Inc: www.anvilintl.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.04 COMBINATION PUMP DISCHARGE VALVES

- A. Manufacturers:
 - 1. Crane Co.: www.cranevalve.com.
 - 2. Taco, Inc: www.taco-hvac.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.05 COMBINATION FLOW CONTROLS

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com.
 - 2. ITT Bell & Gossett: www.bellgossett.com.
 - 3. Tour & Anderson: www.tahydraulics.com
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.
- D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.06 RELIEF VALVES

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com.
 - 2. ITT Bell & Gossett: www.bellgossett.com.
 - 3. Conbraco Industries, Inc: www.conbraco.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide pump suction fitting on suction side of base mounted centrifugal pumps . Remove temporary strainers after cleaning systems.
- F. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps .
- G. Support pump fittings with floor mounted pipe and flange supports.
- H. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
- I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- J. Pipe relief valve outlet to nearest floor drain.
- K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION

SECTION 23 21 23
HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.

1.02 RELATED REQUIREMENTS

- A. Section 23 07 16 - HVAC Equipment Insulation.
- B. Section 23 07 19 - HVAC Piping Insulation.
- C. Section 23 21 13 - Hydronic Piping.
- D. Section 23 21 14 - Hydronic Specialties.
- E. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.
- B. UL 778 - Standard for Motor-Operated Water Pumps; Underwriters Laboratories Inc..

1.04 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- D. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- F. 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 Pump Seals: One set for each type and size of pump.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.
- B. Alignment: Base mounted pumps shall be aligned by qualified millwright.

1.07 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL 778 as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Armstrong Pumps Inc: www.armstrongpumps.com.
- B. ITT Bell & Gossett: www.bellgossett.com.

- C. Taco: www.taco-hvac.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 HVAC PUMPS - GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Products Requiring Electrical Connection: Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

2.03 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psi maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Non-ferrous keyed to shaft.
- D. Bearings: Oil-lubricated bronze sleeve.
- E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Drive: Flexible coupling.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and suction diffuser on pump suction, and line sized combination pump discharge valve (B&G Triple Duty Valve or approved equal) on pump discharge.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Check, align, and certify alignment of base mounted pumps prior to start-up.
- H. Install base mounted pumps on existing concrete housekeeping bases, with anchor bolts, set and level, and grout in place. Provide manufacturer provided spring isolation to support base from concrete housekeeping pad.
- I. Lubricate pumps before start-up.

3.03 SCHEDULES: SEE DRAWINGS FOR SCHEDULES

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cleaning of piping systems.
- B. Chemical treatment.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.
- B. Section 23 21 14 - Hydronic Specialties.
- C. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- D. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- E. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- F. Certificate: Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.
- G. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
- H. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience and approved by manufacturer.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.06 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion.

- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- C. Provide laboratory and technical assistance services during this maintenance period.
- D. Include four hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.
- E. Provide on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.07 MAINTENANCE MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Supply sufficient chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. AmSolv/Division of Amrep, Inc: www.amsolv.com.
- B. GE Water Technologies: www.gewater.com.
- C. Nalco Company: www.nalco.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A. System Cleaner:
 - 1. Manufacturers:
 - a. AmSolv/Division of Amrep, Inc: www.amsolv.com.
 - b. GE Water Technologies: www.gewater.com.
 - c. Nalco Company: www.nalco.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
 - 3. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate).
- B. Closed System Treatment (Water):
 - 1. Manufacturers:
 - a. AmSolv/Division of Amrep, Inc: www.amsolv.com.
 - b. GE Water Technologies: www.gewater.com.
 - c. Nalco Company: www.nalco.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 3. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 - 4. Conductivity enhancers; phosphates or phosphonates.

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by manufacturer.
 - 2. Fill steam boilers only with cleaner and water.
- B. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Contruction Manager, Architect or Engineer of Record.
- D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
- E. Remove, clean, and replace strainer screens.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

- A. Use existing chemical treatment system.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 12 test specimens.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Duct cleaning.

1.02 RELATED REQUIREMENTS

- A. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- B. Section 23 36 00 - Air Terminal Units.
- C. Section 23 37 00 - Air Outlets and Inlets.
- D. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- D. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
- E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.
- H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association.
- I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association.
- J. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association.
- K. SMACNA (DCS) - HVAC Duct Construction Standards.

1.04 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials and duct connections.
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for one inch pressure class and higher systems.
- D. Samples: Submit two samples of typical shop fabricated duct fittings.

- E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- F. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- G. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed specified requirements and recommended fabrication and installation requirements.
- H. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience.

1.07 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

1.08 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

2.02 MATERIALS

- A. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS Type B, with G60/Z180 or G90/Z275 coating.
- B. Steel Ducts: ASTM A 1008/A 1008M, Designation CS, cold-rolled commercial steel or ASTM A 1011/A 1011M, Designation CS, hot-rolled steel.
- C. Stainless Steel Ducts: ASTM A 666, Type 304 or 316.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
- E. Hanger Rod: ASTM A 36/A 36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Provide air foil turning vanes when rectangular elbows must be used.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.
- F. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

- G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.
- B. Install in accordance with manufacturer's instructions.
- C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- H. Use double nuts and lock washers on threaded rod supports.
- I. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- J. At exterior wall louvers, seal duct to louver frame .

3.02 CLEANING

- A. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.03 SCHEDULES

- A. Ductwork Material:
 - 1. Low Pressure Supply (Heating Systems): Galvanized Steel or Aluminum
 - 2. Low Pressure Supply (System with Cooling Coils): Galvanized Steel or Aluminum
 - 3. Medium and High Pressure Supply: Steel.
 - 4. Return and Relief: Galvanized Steel or Aluminum.
 - 5. General Exhaust: Galvanized Steel or Aluminum.
 - 6. Outside Air Intake: Galvanized Steel.
- B. Ductwork Pressure Class:
 - 1. Supply (Heating and Cooling Systems): 1 inch
 - 2. High Pressure Supply (VAV Systems, upstream of VAV Terminal Units): 2 inch.
 - 3. Return and Relief: 1 inch.
 - 4. General Exhaust: 1 inch.
 - 5. Outside Air Intake: 1 inch.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Backdraft dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Flexible duct connections.
- G. Volume control dampers.

1.02 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.
- B. SMACNA (DCS) - HVAC Duct Construction Standards.

1.03 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D. Project Record Drawings: Record actual locations of access doors and test holes.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:
 - 1. Krueger: www.krueger-hvac.com.
 - 2. PCI Industries, Inc; Pottorff Brand : www.pottorff.com.
 - 3. Ruskin Company: www.ruskin.com.
 - 4. Titus: www.titus-hvac.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.

2.02 BACKDRAFT DAMPERS - METAL

2.03 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc: www.louvers-dampers.com.

2. Nailor Industries Inc: www.nailor.com.
3. PCI Industries, Inc; Pottorff Brand : www.pottorff.com.
4. Ruskin Company: www.ruskin.com.
5. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 BACKDRAFT DAMPERS - FABRIC

- A. Fabric Backdraft Dampers: Factory-fabricated, 18 gage, galvanized steel frame.
 1. Blades: Neoprene coated fabric material.
 2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
 3. Maximum Velocity: 1000 fpm (5 m/sec) face velocity.

2.05 DUCT ACCESS DOORS

- A. Manufacturers:
 1. Acudor Products Inc: www.acudor.com.
 2. Nailor Industries Inc: www.nailor.com.
 3. Ruskin Company: www.ruskin.com.
 4. SEMCO Incorporated: www.semcoinc.com.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 1. Less Than 12 inches Square: Secure with sash locks.
 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
 4. Larger Sizes: Provide an additional hinge.
- C. Access doors with sheet metal screw fasteners are not acceptable.

2.06 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.07 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - a. Net Fabric Width: Approximately 2 inches wide.

2.08 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 1. Louvers & Dampers, Inc: www.louvers-dampers.com.
 2. Nailor Industries Inc: www.nailor.com.
 3. PCI Industries, Inc; Pottorff Brand : www.pottorff.com.
 4. Ruskin Company: www.ruskin.com.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- C. Splitter Dampers:

1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
- D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
- E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- F. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- H. Use splitter dampers only where indicated.

END OF SECTION

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof exhausters.
- B. Ceiling exhaust fans.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping Equipment.
- C. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.
- D. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc..
- B. AMCA 204 - Balance Quality and Vibration Levels for Fans.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc. (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- D. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc..
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc..
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc..
- G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.
- H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association.
- I. UL 705 - Power Ventilators; Underwriters Laboratories Inc..

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 5 years of documented experience.
- B. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 FIELD CONDITIONS

- A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

1.07 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Supply two sets of belts for each fan.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Greenheck: www.greenheck.com.
- B. Loren Cook Company: www.lorencook.com.
- C. PennBarry: www.pennbarry.com.
- D. M.K. Plastics: www.mkplastics.com
- E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
- D. Fabrication: Conform to AMCA 99.
- E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 STANDARD ROOF EXHAUSTERS OR VENTILATORS

- A. Product Requirements:
 - 1. Performance Ratings: Determined in accordance with AMCA 210 .
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300.
 - 3. Fabrication: Conform to AMCA 99.
 - 4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- B. Performance and Model: As indicated on drawings.
 - 1. Motor: Refer to Section 23 05 13.
- C. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- D. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- E. Roof Curb: 8 inch high adapter-curb of galvanized steel with continuously welded seams, factory installed nailer strip.
- F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor .

- G. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- H. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.04 LABORATORY ROOF EXHAUSTERS

- A. Product Requirements:
 - 1. Performance Ratings: Determined in accordance with AMCA 210 .
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300.
 - 3. Fabrication: Conform to AMCA 99.
 - 4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- B. Performance and Model: As indicated on drawings.
 - 1. Motor: Refer to Section 23 05 13.
- C. Fan Unit: V-belt or direct driven as indicated, with fiberglass reinforced plastic housing; epoxy-coated steel impeller and stand, stainless steel hardware, resilient mounted TEFC motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- D. Roof Curb: 8 inch high adapter-curb of galvanized steel with continuously welded seams, factory installed nailer strip.
- E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor .
- F. Backdraft Damper: Gravity actuated, epoxy-coated steel multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- G. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.05

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof or wall exhausters with aluminum lag screws to roof curb or structure.
- C. Extend ducts to roof or wall exhausters into roof curb or structure. Counterflash duct to roof or wall opening.
- D. Hung Cabinet Fans:
 - 1. Install fans with resilient mountings and flexible electrical leads.
 - 2. Install fans with resilient mountings and flexible electrical leads. Refer to Section 23 05 48.
 - 3. Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- E. Provide sheaves required for final air balance.
- F. Install backdraft dampers on inlet to roof and wall exhausters.

- G. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable volume terminal units.

1.02 RELATED REQUIREMENTS

- A. Section 23 31 00 - HVAC Ducts and Casings.
- B. Section 23 33 00 - Air Duct Accessories.
- C. Section 23 37 00 - Air Outlets and Inlets.
- D. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and Actuators.

1.03 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association.
- B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc..

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate support and hanging details, and service clearances required.
- E. Project Record Documents: Record actual locations of units.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.
- G. 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 manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 WARRANTY

- A. See Section 01 77 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. See Schedule on Drawings.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MANUFACTURED UNITS

- A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electronic variable volume controls,, hot water heating coils.
- B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.03 SINGLE DUCT VARIABLE VOLUME UNITS

- A. Basic Assembly:
 - 1. Casings: Minimum 22 gage galvanized steel.
 - 2. Lining: Minimum 1/2 inch thick foil coated or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
 - 3. Plenum Air Inlets: S slip and drive connections for duct attachment.
 - 4. Plenum Air Outlets: S slip and drive connections.
- B. Basic Unit:
 - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
 - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.
 - 3. Mount damper operator to position damper normally open.
- C. Hot Water Heating Coil:
 - 1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
- D. Automatic Damper Operator:
 - 1. Electric Actuator: 24 volt with high limit.
- E. Flow Sensor:
 - 1. Center-mount averaging flow sensor with plenum-rated tubing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Support units individually from structure. Do not support from adjacent ductwork.
- C. Connect to ductwork in accordance with Section 23 31 00.
- D. Verify that electric power is available and of the correct characteristics.

3.02 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow. Set units with heating coils for minimum 50 percent full flow.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers.
- B. Registers/grilles.

1.02 RELATED REQUIREMENTS

- A. Section 09 90 00 - Painting and Coating: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc..
- B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc..

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Samples: Submit one of each required air outlet and inlet type.
- D. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.07 MOCK-UP

- A. Provide mock-up of typical interior ceiling module with supply and return air outlets.
- B. Locate where directed or as indicated on drawings.
- C. Mock-up may remain as part of the Work, if approved.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carnes Company HVAC: www.carnes.com.
- B. Krueger: www.krueger-hvac.com.
- C. Price Industries: www.price-hvac.com.
- D. Titus: www.titus-hvac.com.
- E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ROUND CEILING DIFFUSERS

- A. Type: Round, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Diffuser collar shall project not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.

- B. Fabrication: Steel with baked enamel white finish.
- C. Accessories: Radial opposed blade or combination splitter; or damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 RECTANGULAR CEILING DIFFUSERS

- A. Type: Square; multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.
- B. Frame: Surface mount; Snap-in; Inverted T-bar or as indicated. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel or aluminum with baked enamel off-white finish.
- D. Accessories: Radial opposed blade or Combination splitter as indicated and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.04 PERFORATED FACE CEILING DIFFUSERS

- A. Type: Perforated face with fully adjustable pattern and removable face.
- B. Frame: Surface mount; Snap-in; Inverted T-bar; or Spline type as indicated. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel with steel or aluminum frame and baked enamel off-white finish.
- D. Accessories: Radial opposed blade; Butterfly or Combination splitter damper as indicated and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.05 CEILING SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way or two-way or deflection as indicated.
- B. Frame: 1-1/4 inch or 1 inch margin as indicated with countersunk screw; concealed mounting and gasket or as indicated.
- C. Fabrication: Aluminum extrusions with factory off-white enamel finish or as indicated.
- D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face or as indicated.

2.06 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical or horizontal face.
- B. Frame: 1-1/4 inch or 1 inch margin with countersunk screw; concealed mounting or as indicated.
- C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel finish, color to be selected.
- D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
- E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.07 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch or as indicated minimum depth, 3/4 inch or as indicated maximum spacing with spring or other device to set blades, vertical; horizontal face or as indicated, single; double or as indicated deflection.
- B. Frame: 1-1/4 inch; 1 inch or as indicated margin with countersunk screw; concealed or as indicated mounting and gasket.

- C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel finish, color to be selected.
- D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 90 00.

3.02 SCHEDULES

3.03 AIR OUTLET AND INLET SCHEDULE

- A. See Drawings

END OF SECTION

April 30, 2014

SECTION 23 74 13

PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged roof top unit.
- B. Unit controls.
- C. Remote panel.
- D. Mounting curb and base, including adapter curbs.
- E. Maintenance service.

1.02 RELATED REQUIREMENTS

- A. Section 07 62 00 - Sheet Metal Flashing and Trim.
- B. Section 23 05 13 - Common motor requirements for HVAC Equipment.
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- D. Section 23 40 00 - HVAC Air Cleaning Devices.
- E. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Control components, time clocks.
- F. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Installation of thermostats and other controls components.
- G. Section 26 27 17 - Equipment Wiring: Installation and wiring of thermostats and other controls components; wiring from unit terminal strip to remote panel.
- H. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute.
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

PACKAGED OUTDOOR
CENTRAL-STATION
AIR-HANDLING UNITS

April 30, 2014

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.07 WARRANTY

- A. See Gilbane Project Manual, for additional warranty requirements.
- B. Provide a five year warranty to include coverage for refrigeration compressors.

1.08 MAINTENANCE SERVICE

- A. Furnish service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Provide maintenance service with a two month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- D. Submit copy of service call work order or report, and include description of work performed.

1.09 EXTRA MATERIALS

- A. See Gilbane Project Manual, for additional provisions.
- B. Provide two sets of filters.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Johnson Controls / York International Corporation
- B. Trane Company
- C. McQuay
- D. AAON Corporation.
- E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 AIR CONDITIONING UNITS

- A. General: Roof or ground mounted packaged units having hot water heating as scheduled and electric refrigeration.
- B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, , factory-mounted controls, air filters, hot water heating coil, refrigerant cooling coil and compressor with hot-gas bypass or variable-speed compressors and hot-gas reheat circuits, condenser coil and condenser fan as scheduled.
- C. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 27 17.

2.03 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, including access doors with piano hinges and locking handle. Structural members shall be minimum 18 gage, with access doors or panels of minimum 20 gage.

PACKAGED OUTDOOR
CENTRAL-STATION
AIR-HANDLING UNITS

- B. Insulation: two inch thick minimum glass fiber or injected foam, double-walled unit construction.
- C. Supply and Return and Exhaust Fan as scheduled: Backward inclined or airfoil type, resiliently mounted with V-belt drive and adjustable variable pitch motor pulley, and rubber isolated hinge mounted high efficiency motor or direct drive as indicated. Isolate complete fan assembly. Provide factory-mounted variable-frequency drives for all fan motors.
- D. Air Filters: Minimum efficiency reporting value (MERV) of at least 10.
- E. Roof Mounting Curb: Minimum 14 inches high galvanized steel, channel frame with gaskets, nailer strips. See drawings for any special requirements. Provide adapter curbs where necessary to match existing roof penetrations and duct connections.

2.04 EVAPORATOR OR INDOOR COILS

- A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection for cooling coils.
- B. Provide thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.05 COMPRESSOR

- A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gage ports, and filter drier.
- B. Five minute timed off circuit to delay compressor start.
- C. Outdoor thermostat to energize compressor above 35 degrees F ambient.
- D. Provide step capacity control by hot gas by-pass. and/or adjusting variable-speed compressors.
- E. Provide hot-gas reheat coil for humidity control.

2.06 CONDENSER OR OUTDOOR COIL

- A. Provide copper tube aluminum or copper fin coil assembly with subcooling rows and coil guard.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.
- C. Provide refrigerant pressure switches to cycle condenser fans.

2.07 MIXED AIR CASING

- A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fall to closed position.
- B. Gaskets: Provide tight fitting dampers with edge gaskets.
- C. Damper Operator, Units 7.5 Ton Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.
- D. Outdoor airflow monitoring station: Provided at intake of the unit.
- E. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 70 degrees (F) ambient, or when ambient air enthalpy exceeds return air enthalpy.

2.08 OPERATING CONTROLS

- A. Provide factory controller and all necessary sensors and components for operation of refrigerant system, fan VFDs based on static pressure feedback, energy recovery wheel, humidity control function, outdoor air monitoring station for, and economizer function.
- B. Provide BACnet interface on unit for connection of operating controls for BAS control. Control shall allow for modulating heating via the hot-water coil and multiple stages cooling, fan, and

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damper control. See section 23 09 93 for required data to be relayed to the BAS for monitoring and control.

2.09 HEAT RECOVERY

- A. The heat recovery module shall be provided as shown on the drawing and shall have a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seats and bearings.
- B. The energy recovery cassette shall be rated in accordance with ARI Standard 1060 and shall bear the ARI certification symbol.
- C. The energy recovery cassette shall contain a total energy heat wheel constructed of a light weight polymer material with permanently bonded desiccant coating. The energy recovery wheel media shall be capable of removal from the cassette and be cleanable using hot water or light detergent without degrading the latent efficiency.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings or illustrated by the manufacturer.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 90A.
- C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.
- D. Locate remote panels where indicated on drawings.
- E. The unit into BAS as specified.

3.03 SYSTEM STARTUP

- A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

- A. Demonstrate operation to Cecil County Public School's maintenance personnel.

3.05 MAINTENANCE

- A. Provide service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Provide routine maintenance service with a three month interval as maximum time period between calls.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- D. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION

SECTION 26 05 01
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

1.02 RELATED REQUIREMENTS

- A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation .
- D. Report discrepancies to Owner before disturbing existing installation.
- E. Report discrepancies to Architect before disturbing existing installation.
- F. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
 - 3. Make notifications at least 24 hours in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.
- D. Any lighting or ceiling-mounted devices removed during construction must be reinstalled.

END OF SECTION

SECTION 26 05 19

LV ELEC. POWER CONDUCTORS AND CABLES (600V&LESS)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wire and cable for 600 volts and less.
- D. Wiring connectors.
- E. Electrical tape.
- F. Wire pulling lubricant.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 01 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- G. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association.
- H. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association (ANSI/NEMA WC 70/ICEA S-95-658).
- I. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- J. NFPA 70 - National Electrical Code; National Fire Protection Association.
- K. UL 44 - Thermoset-Insulated Wires and Cables.
- L. UL 83 - Thermoplastic-Insulated Wires and Cables.
- M. UL 486A-486B - Wire Connectors.
- N. UL 486C - Splicing Wire Connectors.
- O. UL 486D - Sealed Wire Connector Systems.

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- P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
- Q. UL 1569 - Metal-Clad Cables.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for each cable assembly type.
- C. Samples of Actual Product Delivered: Submit one 18 inch length of cable assembly from each reel.
 - 1. Select each length to include complete set of manufacturer markings.
 - 2. Attach tag indicating cable size and application information.
- D. Test Reports: Indicate procedures and values obtained.
- E. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Project Record Documents: Record actual locations of components and circuits.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

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- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Concealed Dry Interior Locations: Use only building wire in raceway type THHN/THHW.
- D. Exposed Dry Interior Locations: Use only building wire in raceway type THHN/THHW.
- E. Above Accessible Ceilings: Use only building wire in raceway type THHN.
- F. Wet or Damp Interior Locations: Use only building wire in raceway type THW.
- G. Exterior Locations: Use only building wire in raceway type THHW.
- H. Use solid conductor for feeders and branch circuits 10 AWG and smaller.
- I. Use solid conductors for control circuits.
- J. Use conductor not smaller than 12 AWG for power and lighting circuits.
- K. Use conductor not smaller than 16 AWG for control circuits.
- L. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
- M. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

2.02 CONDUCTOR AND CABLE MANUFACTURERS

- A. Cerro Wire LLC: www.cerrowire.com.
- B. Southwire Company: www.southwire.com.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 - 1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
 - 2. Tinned Copper Conductors: Comply with ASTM B33.
- H. Minimum Conductor Size: 12 AWG.
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- I. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.

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3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
 - e. For control circuits, comply with manufacturer's recommended color code.

2.04 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
- E. Conductor: Copper.
 1. For Sizes Smaller Than 4 AWG: Copper.
 2. For Sizes 4 AWG and Larger: Copper.
- F. Insulation Voltage Rating: 600 volts.
- G. Insulation: NFPA 70, Type THHW/THWN/THHN/THW.
- H. Insulation: Thermoplastic material rated 75/90 degrees C.

2.05 METAL-CLAD CABLE

- A. Manufacturers:
 1. AFC Cable Systems Inc: www.afcweb.com.
 2. Encore Wire Corporation: www.encorewire.com.
 3. Southwire Company: www.southwire.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 1. Size 10 AWG and Smaller: Solid.
 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
- G. Grounding: Full-size integral equipment grounding conductor.

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- H. Armor: Steel, interlocked tape.
- I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.
- J. Insulation Temperature Rating: 75/90 degrees C.

2.06 METAL CLAD CABLE

- A. Description: NFPA 70, Type MC.
- B. Conductor: Copper.
 - 1. For Sizes Smaller Than 4 AWG: Copper.
 - 2. For Sizes 4 AWG and Larger: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 90 degrees C.
- E. Insulation Material: Thermoplastic.
- F. Armor Material: Steel.
- G. Armor Design: Interlocked metal tape.
- H. Jacket: PVC.

2.07 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Ideal Industries, Inc: www.idealindustries.com.
 - c. NSI Industries LLC: www.nsiindustries.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 WIRING ACCESSORIES

- A. Electrical Tape:
 - 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 - 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
 - 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. American Polywater Corporation: www.polywater.com.
 - c. Ideal Industries, Inc: www.idealindustries.com.

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- C. Split Bolt Connectors: Description: Connector suitable for copper to copper connection tested and listed to UL 486A requirements. Black burn type-H or equal.
 - 1. Product: Thomas R Betts or equal
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Spring Wire Connectors: Description: Flame retardant thermoplastic shell with plated steel square wire spring gated for 105 degrees C, 600 volts, Thomas and Betts fixed spring wire connectors or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that raceway installation is complete and supported.
- E. Verify that field measurements are as shown on the drawings.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- C. Install metal-clad cable (Type MC) in accordance with NECA 120.
- D. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- G. Terminate cables using suitable fittings.
 - 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- H. Install conductors with a minimum of 12 inches of slack at each outlet.
- I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- J. Make wiring connections using specified wiring connectors.

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1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
- K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- L. Insulate ends of spare conductors using vinyl insulating electrical tape.
- M. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- P. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1.
- Q. Route wire and cable as required to meet project conditions.
1. Wire and cable routing indicated is approximate unless dimensioned.
 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
 3. Include wire and cable of lengths required to install connected devices within 10 ft of location shown.
- R. Use wiring methods indicated.
- S. Pull all conductors into raceway at same time.
- T. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- U. Protect exposed cable from damage.
- V. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
- W. Use suitable cable fittings and connectors.
- X. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- Y. Clean conductor surfaces before installing lugs and connectors.
- Z. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- AA. Use suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
- AB. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- AC. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- AD. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

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- AE. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

3.04 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 45 00.
- B. Perform field inspection and testing in accordance with Section 01 45 00.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- E. Correct deficiencies and replace damaged or defective conductors and cables.
- F. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Grounding and bonding components.
- E. Provide all components necessary to complete the grounding system(s) consisting of:
 - 1. Existing metal underground water pipe.
 - 2. Metal frame of the building.
 - 3. Existing metal underground gas piping system.
 - 4. Metal underground gas piping system.

1.02 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- C. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association.
- E. UL 467 - Grounding and Bonding Equipment.

1.03 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 25 ohms.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide for grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual locations of components and grounding electrodes.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

2.03 MANUFACTURERS

- A. Cooper Power Systems: www.cooperpower.com.
- B. Framatome Connectors International: www.fciconnect.com.
- C. Lightning Master Corporation: www.lightningmaster.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 CONNECTORS AND ACCESSORIES

- A. Mechanical Connectors: Bronze.
 - 1. Product: manufactured by Thomas and Betts or equal.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Wire: Stranded copper.
- C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify existing conditions prior to beginning work.
- E. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Make grounding and bonding connections using specified connectors.

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1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 26 05 53.
- E. Provide bonding to meet requirements described in Quality Assurance.
- F. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Each of branch circuits and feeder circuits shall have dedicated equipment grounding conductor, sharing this conductor with other grounding conductors is not permitted.

3.03 FIELD QUALITY CONTROL

- A. Provide field inspection in accordance with Section 01 45 00.
- B. Inspect and test in accordance with NETA STD ATS except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.03 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.

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- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

2.02 MANUFACTURERS

- A. Thomas & Betts Corporation: www.tnb.com.
- B. Threaded Rod Company: www.threadedrod.com.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized.
- C. Anchors and Fasteners:
 - 1. Do not use powder-actuated anchors.
 - 2. Obtain permission from Architect before using powder-actuated anchors.
 - 3. Concrete Structural Elements: Use precast inserts.
 - 4. Steel Structural Elements: Use beam clamps.
 - 5. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
 - 6. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use hollow wall fasteners.
 - 7. Solid Masonry Walls: Use expansion anchors.
 - 8. Sheet Metal: Use sheet metal screws.
 - 9. Wood Elements: Use wood screws.
- D. Formed Steel Channel:
 - 1. Product: manufactured by [B-Line.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION

SECTION 26 05 34

CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible metal conduit (FMC).
- B. Liquidtight flexible metal conduit (LFMC).
- C. Electrical metallic tubing (EMT).
- D. Conduit fittings.
- E. Conduit, fittings and conduit bodies.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems.
- E. Section 26 05 37 - Boxes.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT).
- C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC).
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association (ANSI/NEMA FB 1).
- G. UL 1 - Flexible Metal Conduit.
- H. UL 360 - Liquid-Tight Flexible Steel Conduit.
- I. UL 514B - Conduit, Tubing, and Cable Fittings.
- J. UL 797 - Electrical Metallic Tubing-Steel.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide for metallic conduit and flexible metal conduit.
- C. Samples of Materials Actually Delivered to Site:
 - 1. Two pieces each of conduit, 2 feet long.
- D. Project Record Documents: Accurately record actual routing of conduits larger than 2 inches.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 CONDUIT REQUIREMENTS

- A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
- C. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.02 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedtube.com.
 - 2. Beck Manufacturing, Inc: www.beckmfg.com.
 - 3. Wheatland Tube Company: www.wheatland.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.03 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com.
 - 2. Electri-Flex Company: www.electriflex.com.
 - 3. International Metal Hose: www.metalhose.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
- D. Description: Interlocked steel construction.
- E. Fittings: NEMA FB 1.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com.
 - 2. Electri-Flex Company: www.electriflex.com.
 - 3. International Metal Hose: www.metalhose.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

- C. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
- D. Description: Interlocked steel construction with PVC jacket.
- E. Fittings: NEMA FB 1.

2.05 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com.
 - 2. Beck Manufacturing, Inc: www.beckmfg.com.
 - 3. Wheatland Tube Company: www.wheatland.com.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
- D. Fittings and Conduit Bodies: NEMA FB 1; steel set screw type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify routing and termination locations of conduit prior to rough-in.
- E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Connections and Terminations:
 - 1. Use suitable adapters where required to transition from one type of conduit to another.
 - 2. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 - 3. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 - 4. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- E. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- F. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where conduits are subject to earth movement by settlement or frost.
- G. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- H. Provide grounding and bonding in accordance with Section 26 05 26.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- B. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation specified in Section roofing section.

END OF SECTION

SECTION 26 05 37

BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Wall and ceiling outlet boxes.
- D. Floor boxes.
- E. Pull and junction boxes.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
- F. Section 26 27 26 - Wiring Devices: Wall plates in finished areas, floor box service fittings, fire-rated poke-through fittings, and access floor boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association (ANSI/NEMA FB 1).
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association (ANSI/NEMA OS 1).
- E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association (ANSI/NEMA OS 2).
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- J. UL 508A - Industrial Control Panels.
- K. UL 514A - Metallic Outlet Boxes.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use suitable concrete type boxes where flush-mounted in concrete.
 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Use shallow boxes where required by the type of wall construction.
 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 12. Wall Plates: Comply with Section 26 27 26.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

2.02 MANUFACTURERS

- A. Appleton Electric: www.appletonelec.com.
- B. Arc-Co./Division of Arcade Technology: www.arc-co.com.
- C. Unity Manufacturing: www.unitymfg.com.
- D. Substitutions: Reco, Inc. See Section 01 60 00 - Product Requirements.
- E. Steelcity

2.03 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- B. Nonmetallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.04 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron; Cast Aluminum.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- C. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
 - 1. Material: Galvanized cast iron; Cast Aluminum.
 - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 - 3. Cover Legend: "ELECTRIC".

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- E. Install boxes plumb and level.
- F. Flush-Mounted Boxes:
 - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.

2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- G. Install boxes as required to preserve insulation integrity.
- H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- J. Close unused box openings.
- K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- L. Provide grounding and bonding in accordance with Section 26 05 26.
- M. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- N. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- O. Coordinate installation of outlet boxes for equipment connected under Section 26 27 17.
- P. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- Q. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
- R. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- S. Maintain headroom and present neat mechanical appearance.
- T. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- U. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- V. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- W. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- X. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- Y. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- Z. Use flush mounting outlet box in finished areas.
- AA. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- AB. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.
- AC. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- AD. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- AE. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- AF. Use adjustable steel channel fasteners for hung ceiling outlet box.
- AG. Do not fasten boxes to ceiling support wires.

- AH. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- AI. Use gang box where more than one device is mounted together. Do not use sectional box.
- AJ. Use gang box with plaster ring for single device outlets.
- AK. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- AL. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- AM. Set floor boxes level.
- AN. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.03 ADJUSTING

- A. Adjust floor boxes flush with finish flooring material.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

3.04 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Warning signs and labels.
- F. Field-painted identification of conduit.

1.02 RELATED REQUIREMENTS

- A. Section 09 90 00 - Painting and Coating.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- C. Section 26 27 26 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association.
- D. UL 969 - Marking and Labeling Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.07 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements for additional requirements.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Motor Control Centers:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - e. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 4) Identify coil voltage.
 - 5) Identify load(s) and associated circuits controlled. Include location.
 - f. Transfer Switches:
 - 1) Identify voltage and phase.

- 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
 - c. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.
3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
- C. Identification for Conductors and Cables:
 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
- D. Identification for Raceways:
 1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
 2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Color Code:
 - 2) Field-Painting: Comply with Section 09 90 00.
 - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.
 3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
- E. Identification for Boxes:
 1. Use voltage markers to identify highest voltage present.
 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 09 90 00 per the same color code used for raceways.

- 1) Emergency Power System: Red.
3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.
- F. Identification for Devices:
 1. Factory Pre-Marked Wallplates: Comply with Section 26 27 26.

2.02 MANUFACTURERS

- A. Brady Corporation: www.bradycorp.com.
- B. Seton Identification Products: www.seton.com/aec.
- C. HellermannTyton: www.hellermannityton.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
 - c. Seton Identification Products: www.seton.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com.
 - b. Brother International Corporation: www.brother-usa.com.
 - c. Panduit Corp: www.panduit.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for General Information and Operating Instructions:
 1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.

3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/4 inch.
 5. Color: Black text on white background unless otherwise indicated.
- D. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
 2. Legend: Load controlled or other designation indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch.
 5. Color: Black text on clear background.
- E. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- F. Locations:
1. Each electrical distribution and control equipment enclosure.
 2. Communication cabinets.
 3. Disconnect switches, and starters.
- G. Letter Size:
1. Use 1/8 inch letters for identifying individual equipment and loads.
 2. Use 1/4 inch letters for identifying grouped equipment and loads.

2.04 WIRE AND CABLE MARKERS

- A. Manufacturers:
1. Brady Corporation: www.bradyid.com.
 2. HellermannTyton: www.hellermannntyton.com.
 3. Panduit Corp: www.panduit.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.
- H. Description: split sleeve type wire markers.
- I. Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, and junction boxes each load connection.
- J. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
 2. Control Circuits: Control wire number indicated on shop drawings.

2.05 VOLTAGE MARKERS

- A. Manufacturers: Panduit Corp
1. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

- D. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
- F. Color: Black text on orange background unless otherwise indicated.
- G. Location: Furnish markers for each conduit longer than 6 feet.
- H. Spacing: 20 feet on center.
- I. Color:
 - 1. 480 Volt System: Brown.
 - 2. 208 Volt System: Yellow.
 - 3. Fire Alarm System: Red.
- J. Legend:
 - 1. 480 Volt System: brown.
 - 2. 208 Volt System: yellow.
 - 3. Fire Alarm System: red.

2.06 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com.
 - 3. Seton Identification Products: www.seton.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 - b. Provide polyester overlamine to protect handwritten text.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

- B. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.
- G. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Switchboards.
- B. Switchboard accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. ANSI C12.1 - American National Standard Code for Electricity Metering.
- B. ANSI C39.1 - American National Standard Requirements for Electrical Analog Indicating Instruments; 1981 (R1992).
- C. IEC 60051-1 - Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories - Part 1: Definitions and General Requirements Common To All Parts;.
- D. IEC 60051-2 - Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories - Part 2: Special Requirements for Ammeters and Voltmeters.
- E. IEEE C12.1 - American National Standard Code for Electricity Metering; Institute of Electrical and Electronic Engineers; 1988.
- F. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; Institute of Electrical and Electronic Engineers.
- G. NECA 400 - Standard for Installing and Maintaining Switchboards (ANSI); National Electrical Contractors Association.
- H. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association.
- I. NEMA PB 2 - Deadfront Distribution Switchboards; National Electrical Manufacturers Association.
- J. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- K. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.
- D. Test Reports: Indicate results of factory production tests.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Project Record Documents: Record actual locations of switchboards.

- G. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- H. 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. Enclosure Keys: Two of each different key.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in 48 inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SWITCHBOARDS

- A. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.
- B. Ratings:
 - 1. Voltage: 120/208; 277/480 volts.
 - 2. Configuration: Three phase, four wire, grounded.
 - 3. Main Bus: 2000 amperes.
 - 4. Integrated Equipment Rating: 200,000 rms amperes symmetrical.
- C. Main Section Devices: Individually mounted and compartmented.
- D. Distribution Section Devices: Individually mounted and compartmented.
- E. Bus Material: Copper with tin plating, standard size.
- F. Bus Connections: Bolted, accessible from front for maintenance.
- G. Fully insulate load side bus bars
- H. Ground Bus: Extend length of switchboard.
- I. Insulated Ground Bus: Extend length of switchboard.
- J. Molded Case Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole.
 - 1. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

2. Include shunt trip where indicated.
- K. Solid-State Molded Case Circuit Breakers: With electronic sensing, timing and tripping circuits for adjustable current settings; UL listed.
 1. Ground fault trip, ground fault sensing integral with circuit breaker.
 2. Instantaneous trip.
 3. Adjustable short time trip.
 4. Stationary mounting.
 5. Include shunt trip where indicated.
- L. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.
- M. Ground Fault Sensor: Zero sequence type.
- N. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
- O. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.
- P. Enclosure: Type 1 - General Purpose.
 1. Align sections at front and rear.
 2. Switchboard Height: 91-50 inches, excluding floor sills, lifting members and pull boxes.
 3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
 4. Structure: Free standing, self supporting.

2.03 POWER METERS

- A. Manufacturers:
 1. Square D - Powerlogic Series 800 power meters or equal.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Watt-Hour Meters and Wattmeters: ANSI C12.1, three phase induction type with two stators, each with current and potential coil, rated 5 amperes and 120 volts at 60 Hertz.
 1. Meter suitable for connection to 3- and 4-wire circuits.
 2. Potential indicating lamps.
 3. Adjustments for light and full load, phase balance, and power factor.
 4. Digital register.
 5. Integral demand indicator.
 6. Ratchets to prevent reverse rotation.
 7. Removable meter with draw-out test plug.
 8. Semi-flush mounted case with matching cover.
- C. Provide meters with appropriate multiplier tags.

2.04 METERING TRANSFORMERS

- A. Manufacturers:
 1. Square D or equal.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Current Transformers: IEEE C57.13, 5 ampere secondary, wound; bushing; bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

- C. Potential Transformers: IEEE C57.13, 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.05 SOURCE QUALITY CONTROL

- A. Shop inspect and test switchboard according to NEMA PB 2.
- B. Make completed switchboard available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide concrete housekeeping pad under the provisions of Section 03 30 00.
- B. Verify that field measurements are as instructed by manufacturer.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 45 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.1.

3.03 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.
- C. Adjust circuit breaker trip and time delay settings to values indicated.
- D. Adjust circuit breaker trip and time delay settings to values as instructed by Architect.

3.04 CLEANING

- A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 28 13 - Fuses: Fuses for fusible switches and spare fuse cabinets.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association.
- F. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association.
- G. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association.
- H. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association.
- I. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- J. NFPA 70 - National Electrical Code; National Fire Protection Association.
- K. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- L. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- M. UL 67 - Panelboards.
- N. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 MAINTENANCE MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Furnish two of each panelboard key.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ALL PANELBOARDS

- A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

- 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
- F. Manufacturers:
 - 1. SQ.D or Equal.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Description: NEMA PB 1, circuit breaker type.
- H. Service Conditions:
 - 1. Altitude: 1000 feet.
 - 2. Temperature: 55 degrees F.
- I. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.
- J. Minimum integrated short circuit rating: As indicated.
 - 1. 240 Volt Panelboards: 14,000 amperes rms symmetrical.
 - 2. 480 Volt Panelboards: 21,000 amperes rms symmetrical.
- K. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.
- L. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.
- M. Current Limiting Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole; UL listed. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- N. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.
- O. Enclosure: NEMA PB 1, Type 1, 5 3/4" deep, 20" wide, cabinet box. With continued hinge and lock.
- P. Cabinet Front: Surface type, fastened with , hinged door with flush lock, finished in manufacturer's standard gray enamel.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Aluminum.
 - 3. Ground Bus Material: Aluminum.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Provide clear plastic circuit directory holder mounted on inside of door.
- F. Manufacturers:
 - 1. SQ.D or Equal.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
- H. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.
- I. Minimum Integrated Short Circuit Rating: As indicated.
 - 1. 240 Volt Panelboards: 14,000 amperes rms symmetrical.
 - 2. 480 Volt Panelboards: 21,000 amperes rms symmetrical.
- J. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for all poles; UL listed.
 - 1. Type SWD for lighting circuits.
 - 2. Type HACR for air conditioning equipment circuits.
 - 3. Class A ground fault interrupter circuit breakers where scheduled.
 - 4. Do not use tandem circuit breakers, or miniature circuit breakers.
- K. Current Limiting Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole; UL listed. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- L. Enclosure: NEMA PB 1, Type 1.
- M. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.
- N. Cabinet Front: Flush or Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.05 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install panelboards plumb.
- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- I. Provide grounding and bonding in accordance with Section 26 05 26.
- J. Install all field-installed branch devices, components, and accessories.
- K. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.
- L. Install panelboards plumb. Install recessed panelboards flush with wall finishes, where installed surface mounted secure or anchor panelboard to brick or cinder block wall.
- M. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- N. Provide filler plates to cover unused spaces in panelboards.
- O. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
- P. Provide typed or neatly handwritten circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- Q. Provide identification nameplate for each panelboard in accordance with Section 26 05 53.
- R. Provide arc flash warning labels in accordance with NFPA 70.

- S. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
 - 1. Minimum spare conduits: 5 empty 1 inch.
- T. Ground and bond panelboard enclosure according to Section 26 05 26.

3.02 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 45 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Correct deficiencies and replace damaged or defective panelboards or associated components.
- D. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.03 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 26 27 17
EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 34 - Conduit.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 05 37 - Boxes.
- D. Section 26 27 26 - Wiring Devices.

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association.
- B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 4. Product:

- 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Disconnect Switches: As specified in Section and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 27 26.
- D. Flexible Conduit: As specified in Section 26 05 34.
- E. Wire and Cable: As specified in Section 26 05 19.
- F. Boxes: As specified in Section 26 05 37.

2.02 EQUIPMENT CONNECTIONS

- A. As required by equipment manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 37 - Boxes.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association.
- E. NEMA WD 6 - Wiring Device -- Dimensional Specifications; National Electrical Manufacturers Association.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association.
- G. UL 20 - General-Use Snap Switches.
- H. UL 498 - Attachment Plugs and Receptacles.
- I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cooper Wiring Devices: www.cooperwiringdevices.com.
- B. Leviton Manufacturing, Inc: www.leviton.com.

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

2.02 ALL WIRING DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 WALL SWITCHES

- A. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
1. Body and Handle: White plastic with toggle handle.
 2. Ratings:
 - a. Voltage: 120 - 277 volts, AC.
 - b. Current: 20 amperes.
 3. Ratings: Match branch circuit and load characteristics.
- C. Switch Types: Single pole, double pole, 3-way, and 4-way.

2.04 RECEPTACLES

- A. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
- B. Receptacles: Heavy duty, complying with NEMA WD 6 and WD 1.
1. Device Body: White plastic.
 2. Configuration: NEMA WD 6, type as specified and indicated.
- C. Convenience Receptacles: Type 5 - 20.
- D. Single Convenience Receptacles.
- E. Duplex Convenience Receptacles.
- F. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.05 TELEPHONE JACKS

- A. Product: AMP manufacturing
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.06 WALL PLATES

- A. All Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Decorative Cover Plates: stainless steel.
- C. Jumbo Cover Plates: stainless steel.
- D. Weatherproof Cover Plates: Gasketed cast metal with hinged cover.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that openings in access floor are in proper locations.
- H. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
- C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
- D. Install wiring devices in accordance with manufacturer's instructions.
- E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- I. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Install receptacles with grounding pole on top.
- Q. Connect wiring device grounding terminal to outlet box with bonding jumper.
- R. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- S. Connect wiring devices by wrapping conductor around screw terminal.
- T. Use jumbo size plates for outlets installed in masonry walls.
- U. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.04 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 to obtain mounting heights.
- B. Install wall switch 48 inches above finished floor.
- C. Install convenience receptacle 18 inches above finished floor.
- D. Install convenience receptacle 6 inches above backsplash of counter.
- E. Install telephone jack 18 inches above finished floor.
- F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.
- G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

3.05 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, adjusting, and balancing in accordance with Section 01 45 00.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Operate each wall switch with circuit energized and verify proper operation.
- E. Verify that each receptacle device is energized.
- F. Test each receptacle to verify operation and proper polarity.
- G. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- H. Correct wiring deficiencies and replace damaged or defective wiring devices.
- I. Verify that each telephone jack is properly connected and circuit is operational.

3.06 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.07 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fuses.

1.02 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.03 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 MAINTENANCE MATERIALS

- A. See Section 01 60 00 - Product Requirements, for additional provisions.
- B. Furnish two fuse pullers.
- C. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com.
- B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.
- C. Littelfuse, Inc: www.littelfuse.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 APPLICATIONS

- A. Service Entrance:
 - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
- B. Feeders:
 - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
- C. Individual Motor Branch Circuits: Class RK1, time-delay.
- D. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
 - 1. Class RK1, Time-Delay Fuses:
 - a. Products:
 - 1) BUSS MAN.
 - 2) COOPER.
 - 3) Substitutions: See Section 01 60 00 - Product Requirements.
- H. Class CC Fuses: Comply with UL 248-4.
 - 1. Class CC, Time-Delay Fuses:
 - a. Products:
 - 1) BUSSMAN.
 - 2) COOPER.
 - 3) Substitutions: See Section 01 60 00 - Product Requirements.
- I. Power Load Feeder Switches: Class RK1 (time delay).
- J. Motor Load Feeder Switches: Class RK1 (time delay).
- K. Other Feeder Switches: Class RK1 (time delay).
- L. General Purpose Branch Circuits: Class RK1 (time delay).
- M. Motor Branch Circuits: Class L time delay.
- N. Lighting Branch Circuits: Class G.

2.04 CLASS RK1 (TIME DELAY) FUSES

- A. Manufacturers:
 - 1. Bussman Corp.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction: Current limiting, dual-element fuse, 10 seconds minimum at 500% rated amps, with copper fuse element.

2.05 CLASS G FUSES

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.

- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 28 18
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.
- B. Fusible switches.
- C. Nonfusible switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 28 13 - Fuses.
- E. Section 26 29 13 - Enclosed Controllers: Manual motor controllers.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association.
- D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association.
- E. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- F. NFPA 70 - National Electrical Code; National Fire Protection Association.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 98 - Enclosed and Dead-Front Switches.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual locations of enclosed switches.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- 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.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between 55 degree F and 75 degree F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Siemens Industry, Inc: www.usa.siemens.com.
- B. Eaton Corporation; Cutler-Hammer Products; Model : www.eaton.com.
- C. General Electric Company; Model : www.geindustrial.com.
- D. Schneider Electric; Square D Products; Model : www.schneider-electric.us.
- E. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break, enclosed safety switches complying with NEMA KS 1, type HD (heavy duty), and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- I. Conductor Terminations: Suitable for use with the conductors to be installed.
- J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- L. Enclosures: Comply with NEMA KS 1 and NEMA 250, and list and label as complying with UL 50 and UL 50E.
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
- M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- N. Heavy Duty Switches:
 1. Products:
 - a. SQD.
 - b. SIEMENS.
 - c. GE.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper, suitable for terminating copper conductors only.
 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
 - a. Provide means for locking handle in the ON position where indicated.

2.03 COMPONENTS

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 2. Handle lockable in OFF position.
 3. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.
- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 2. Handle lockable in OFF position.
- C. Enclosures: NEMA KS 1.
 1. Interior Dry Locations: Type 1.
 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install enclosed switches in accordance with manufacturer's instructions.
- B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Provide identification nameplate for each enclosed switch in accordance with Section 26 05 53.
- J. Provide arc flash warning labels in accordance with NFPA 70.
- K. Install fuses in fusible disconnect switches.
- L. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Magnetic motor controllers.
- B. Combination magnetic motor controllers and disconnects.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- B. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association.
- C. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association.
- D. NEMA ICS 6 - Industrial Control and Systems: Enclosures; National Electrical Manufacturers Association.
- E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association.
- F. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Test Reports: Indicate field test and inspection procedures and test results.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Maintenance Data: Replacement parts list for controllers.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Product: www.eaton.com.
- B. General Electric Company: www.geindustrial.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 AUTOMATIC CONTROLLERS

- A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Coil Operating Voltage: 120 volts, 60 Hertz.
- C. Overload Relays: NEMA ICS 2; bimetal.
- D. Enclosures: NEMA ICS 6, Type 1.

2.03 ACCESSORIES

- A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.
- B. Cover Mounted Pilot Devices: NEMA ICS 5, standard duty oiltight type.
- C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
- D. Indicating Lights: Transformer, LED type.
- E. Selector Switches: Rotary type.
- F. Relays: NEMA ICS 2.
- G. Control Power Transformers: 120 volt secondary, 50 VA minimum, in each motor starter. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.04 DISCONNECTS

- A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.
- B. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
- B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- C. Provide supports in accordance with Section 26 05 29.
- D. Height: 5 ft to operating handle.
- E. Provide fuses for fusible switches; refer to Section 26 28 13 for product requirements.
- F. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- G. Identify enclosed controllers in accordance with Section 26 05 53.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 45 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.

- C. Perform inspections and tests listed in NETA STD ATS, Section 7.16.1.

END OF SECTION