SPC St. Petersburg College

PALLADIUM BUILDING

Stavros Room HVAC Renovation

SPC Project #265-S-17-3

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ARCHITECTURAL INDEX

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SECTION 02050

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK: Demolition includes the dismantling and removal of all designated portions of buildings. Demolition includes capping of disconnected utilities, whether active or inactive, filling any voids created by material removal, and compliance with hazardous material regulations.

1.02 QUALITY ASSURANCE:

A. Comply with Federal, State, Local and other duly constituted authorities in matters pertaining to:

1. Permitting.

2. Notification of affected utility agencies before commencing work.

3. Disposal of and hauling of debris, trash and demolition remnants.

4. Safety Precautions.

5. Protection of environmental matters and conformance to applicable regulatory procedures when hazardous or contaminated materials are discovered.

B. Notify the Architect immediately if previously unknown obstructions are found after work has commenced.

C. Operations shall be conducted to prevent damage by falling or windblown debris or other cause to adjacent buildings, persons, and property.

1.03 PROJECT RECORD DOCUMENTS: Location of capped utilities must be accurately located, both horizontally and vertically for inclusion in certified project record documents.

1.04 JOB CONDITIONS:

A. Cutting and Patching:

1. In general, all cutting shall be done by the respective Contractors or Subcontractors, requiring such cutting to properly install his work, except as herein specified, and the patching shall be done by the General Contractor.

2. Where new mechanical piping, ductwork, or other mechanical installations are to be furnished and installed under the Mechanical Contractor or where new electrical conduits, wiring or other electrical installations are to be furnished and installed under the electrical contract, the following procedures shall be followed:

a. The removal and replacement of any existing architectural elements (i.e., ceilings, partitions, floors, etc.), or portions of same, required for the installation of such work as outlined in Paragraph B above shall be the responsibility of the General Contractor including the restoration of such

removals to their original condition.

b. The removal and replacement of any ductwork, piping or any other mechanical equipment or portion of same, required for the installation of such work as outlined in Paragraph B above shall be the responsibility of the Mechanical Contractor including the restoration of such removals to their original condition.

c. The removal and replacement of any lighting fixtures, conduits, wiring or other electrical installations, or portions of same required for the installation of such work as outlined in Paragraph B above, shall be the responsibility of the Electrical Contractor including the rehanging of fixtures and restoration of such removals to their original condition.

d. Where it is necessary to cut openings through concrete structural slabs and masonry walls, the Contractor is to use a carborundum or diamond drill and/or coring bit.

3. All patching shall match the surrounding work and shall be done in such manner as to create a workmanlike appearance upon completion, including painting of entire walls where such patching occurs, to the complete satisfaction of the Architect.

PART 2 - PRODUCTS

2.01 Not used

PART 3 - EXECUTION

3.01 PREPARATION:

A. Provide, erect and maintain erosion control devices, temporary barriers, and security devices at locations indicated. During non-working hours barricades, closures, warning lights or other measures will be used to secure the area.

B. Protect existing landscaping materials, appurtenances, and structures which are not to be demolished. Repair damage caused by demolition operations at no cost to Owner.

C. Provide adequate bracing and shoring to prevent movement or settlement of adjacent structures.

D. Protect and maintain in safe and operable condition the utilities to remain. Prevent interruption of existing utility service to occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing facilities as acceptable to governing authorities and the Owner's representative. Provisions for reconnection of or capping and plugging of any electrical, piping or utility work is indicated on the drawings. All reconnections shall be made in a manner which will leave the work safely and properly functioning or disconnected as required in a proper structural and repaired condition and with a workmanlike and aesthetically pleasing appearance where visible.

3.02 DEMOLITION REQUIREMENTS:

A. Conduct demolition to minimize interference with adjacent structures indicated to remain.

B. Cease operations immediately of adjacent structures appear to be in danger. Notify authority having jurisdiction. Do not resume operations until directed.

C. Conduct operations with minimum interference to public or private access. Maintain ingress and egress at all times. Temporary barricades and other safety measures shall be erected around hazardous areas all in accordance with Federal, State and Local ordinances.

D. Sprinkle work with water to minimize dust. Provide hoses and water connections.

E. Comply with governing regulations pertaining to environmental protection.

F. Clean adjacent structures and improvements of dust, dirt and debris caused by demolition operations. Return adjacent areas to condition existing prior to start of work.

3.03 DISPOSAL OF DEMOLISHED MATERIALS:

A. Remove from site debris, rubbish and other materials resulting from demolition operations.

B. No burning of any material, debris or trash on-site or off-site will be allowed.

C. Transport materials removed from demolished structures with appropriate vehicles and dispose off-site to areas which are approved for disposal by governing authorities.

● END OF SECTION ●

SECTION 09250

GYPSUM DRYWALL

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK: Provide, in place, all Drywall Work and accessories as shown on Drawings, as specified herein, and as required for the complete installation.

1.02 REFERENCE STANDARDS: Comply with all applicable requirements of ANSI A97.1 and Gypsum Association (GA) GA-216 "Recommended Specifications for the Application and Finishing of Gypsum Board," except where more stringent requirements are called for herein, in local codes, or by wallboard manufacturer.

1.03 SUBMITTALS: None Required.

1.04 MATERIALS HANDLING:

A. Protection: Use necessary means to protect all materials before, during and after installation and to protect installed Work of all other trades.

B. Replacements: In event of damage, immediately make all repairs and replacements necessary to Architect's approval at no cost to Owner.

C. Delivery/Storage: Deliver all materials to job site in original unopened containers with all labels intact and legible at time of use. Store in strict accordance with manufacturer's recommendations as approved by Architect.

1.05 PRECONDITIONS:

A. Inspection: All Work herein requires coordination with trades whose Work connects with, is affected or concealed by, drywall. Prior to drywall installation, carefully inspect the installed Work of all other trades and verify such Work is complete and that drywall is installed in strict accordance with all pertinent codes and regulations, manufacture's recommendations as approved by Architect, and the original design.

B. Discrepancy: Do not install drywall until all unsatisfactory conditions have been corrected to Architect's approval.

PART 2 - PRODUCTS

2.01 WALL MATERIALS:

A. Approved Manufacturers:

1. United States Gypsum
2. National Gypsum
3. Georgia Pacific

B. Gypsum Board: Conforming to ASTM C-36, 5/8" thick x 4' wide.

C. Unrated Partitions & Ceilings: Regular.

D. Wet Areas: Water Resistant.

2.02 WALLBOARD ACCESSORIES:

A. Trim and Edging: 26 gauge, electro-galvanized steel, with knurled surfaces for bedding cement. Provide angle corner pieces with 1-1/4" legs at all external corners and channel type metal trim pieces as detailed at all gypsum board edges meeting dissimilar materials.

B. Nails: Annular ring type, lengths as required by gypsum board thickness.

C. Screws: As required for proper installation according to manufacturer's recommendations.

D. Laminating Adhesives: As recommended by manufacturer of gypsum board.

E. Neoprene Filler: Closed cell sponge neoprene strips, ½" x 5/8" section, supplied in 50 foot coils with adhesive coating on one 5/8" side, meeting Military Specification C-3133, SC41, black color.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. One week prior to commencing drywall work this Contractor shall notify the General Contractor and the HVAC Contractor of this starting date so that proper precautions may be taken by these Contractors to prevent drywall dust from contaminating the air handling and ductwork systems. See Mechanical Specifications regarding filters to be used during construction.

B. Install drywall with the separate boards in moderate contact; not forced into place. At internal and external corners, conceal cut edges by overlapping the covered edges of abutting boards. Stagger boards so corner of any four boards will not meet a common point except in vertical corners. Do all cutting and patching required to accommodate Work of other trades.

C. Install drywall ceilings, where indicated, with long dimension of board at right angles to supporting members, except that board may be installed with long dimension parallel to any supporting members that are indicated as spaced 16" on center, when attachment members are provided at end joints.

D. Install drywall walls, where indicated, to studs at right angles to furring or framing members. Make end joints, as required, over furring or framing members.

E. If framing members are out of alignment, bowed or warped, correct to make true surfaces before application of boards; use correction method approved by Architect. Make finish walls or ceilings plumb and level, free of unevenness at joints and without ridges, bows or warps.

F. Minimum temperature in area where wall board is being installed shall be 50°F. Do not work in cold weather unless this requirement is properly fulfilled.

G. Joints in wallboard shall be butted loose. Maximum gap at end joints shall be 1/4". Do not place butt ends against a tapered edge.

H. Install wallboard so that no end joints occur on any surface where the least dimension is not over 12 feet and not pierced by ducts or pipes. Fill in and neatly fit wallboard in areas between and around ducts and pipes. Make certain all edges of wallboard are securely fastened. See also Metal Framing 09110 and note the double studding around all openings.

I. Install wallboard in maximum practicable lengths to avoid any end joints.

J. Where ducts or pipes pierce insulated partitions, pack the openings between drywall and ducts or pipes with insulation.

K. Lay out wallboard so that end joints do not align with nor occur within 12" of parallel edges of openings.

L. Provide control joints in long wallboard runs at maximum 30 foot centers.

M. Wallboard supports shall not extend across control joints.

N. Where wallboard is to be installed on exterior studs or furring on masonry walls apply 6 mil polyethylene vapor barrier prior to installing the wallboard. This applies to all masonry walls and exterior studs whether or not it is called for on plans or details.

3.02 JOINTING AND FINISHING:

A. Inspect all joint areas; be certain wallboard fits snugly against supporting framework.

B. In jointing and finishing areas, maintain temperature not less than 55° for 24 hours prior to starting, for entire period of jointing, and until all compounds have dried.

C. Apply jointing and finishing compound by machine or hand tool. Provide minimum 24 hours drying time between coats, with additional drying time in poorly ventilated areas.

D. Embedding Compound: Apply to joints and fastener heads in thin, uniform layer. Spread not less than 3" wide at joints; center reinforcing tape in the joint and embed tape in compound. Then spread thin layer of compound over tape. After compound has dried, apply second coat to joints and fastener heads, spreading in think uniform coat not less than 6" wide at joints, feather-edged. When thoroughly dry, sandpaper to eliminate ridges and high points.

E. On gypsum drywall not scheduled for a One-Coat Veneer Plaster Finish, provide a Level 5 finish as defined by the "Gypsum Construction Handbook".

F. Internal Corners: Treat as specified above for joints, except fold reinforcing tape lengthwise through the middle and fit neatly into corner.

G. External Corners: Fir corner bead neatly over corner; secure with same type fasteners used for wallboard, spacing fasteners approximately 6" on center and driving through wallboard into framing or furring member. After corner piece is secured in position, treat corner with joint compound and reinforcing tape as specified above for joints, feathering compound out from 8" to 10" on each side of corner.

3.03 METAL TRIM:

A. Drawings do not necessarily show all locations and all requirements for metal trim in connection with the Work. Carefully study Drawings and the installation; provide in place all metal trim normally recommended by the drywall manufacturer.

B. Install metal trim in strict accordance with manufacturer's recommended installation methods; provide no lesser embedment and finishing than specified above for corner treatment.

3.04 PATCHING: After application of drywall trim and before painting, remedy all damage and defects in drywall surfaces so that no imperfections will be visible after the second coat of paint is applied.

3.05 CLEAN-UP: In addition to the requirements of the GENERAL CONDITIONS, use all necessary care during execution of the Work of this Section to prevent undue scattering of drywall scraps and dust and to prevent tracking of joint and finishing compounds onto floor surfaces. On completion of each installation segment in a room or space, promptly pick up and remove from the working area all scraps, debris and surplus materials.

3.06 REPEAT-CLEANING: THE CONTRACTOR IS CAUTIONED TO REMEMBER THAT HE WILL BE REQUIRED TO CLEAN FLOORS OF ALL DROPPINGS. HE WILL BE ADVISED TO KEEP ALL SURFACES CLEAN.

• END OF SECTION •

SECTION 09510

ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK: Supply and install all Acoustical Unit Work as shown on Drawings and as specified herein.

1.02 SUBMITTALS: Within 45 calendar days of Contract award submit the following:

A. Shop Drawings:

1. Complete layout of all systems including attachments, intersections of members and edge conditions.

2. Two samples of each type of unit specified herein.

B. WARRANTY: Provide 15 year written warranty against sag of ceiling panels or rusting of grid.

1.03 APPLICATOR:

A. Contractor Qualifications: Ceiling systems contractor, approved by manufacturer of material or system, must have at least five years experience in the furnishing and installation of ceiling systems. Submit experience record, if requested.

B. Other Work supported by or penetrating through suspended ceiling systems, including partition systems, both fixed and tracked (if any), light fixtures, HVAC equipment, fire protection systems, speakers (if any), and movie screens (if any).

1.04 COORDINATION: Work hereunder requires coordination with trades whose Work connects with, is affected, or concealed by acoustical units. Before proceeding with Work, make certain all required inspections have been made.

1.05 INSPECTION: Examine subsurfaces to receive Work. Commencement of Work will be construed as acceptance of all subsurfaces and acceptance of all humidity and temperature conditions..

1.06 DELIVERY AND STORAGE:

A. Deliver materials to project site in manufacturer's unopened containers, indicating manufacturer's name, brand, type, style, size, color, texture, and other identifying information.

B. Store materials in a dry location,. conforming to job site conditions specified, off the ground, and in a manner to prevent damage, deterioration, and intrusion of foreign matter. Replace materials which have been damaged or are otherwise unsuitable. When damage or unsuitability is ascertained, immediately remove all damaged or otherwise unsuitable material from job site, and replace with new and like material, at no additional cost to Owner.

1.07 STANDARDS: Comply with all applicable requirements of standards as follows:

A. ASTM A123 "Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products".

B. ASTM A446 "Standard Specification for Steel Sheet, ZincCoated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality".

C. ASTM A525 "Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process".

D. ASTM A641 "Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire".

E. ASTM C423 "Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method".

F. ASTM C635 "Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings"

G. ASTM C636 "Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels".

H. ASTM E84 "Standard Test Method for Surface Burning Characteristics of Building Materials".

I. ASTM E413 "Standard Classification for Determination of Sound Transmission Class".

J. ASTM E1234 "Standard Classification for Acoustical Ceiling Products".

K. Ceilings & Interior Systems Contractors Association (CISCA) Handbook.

1.08 EXTRA STOCK: Order additional three percent of each type of acoustical unit specified, for maintenance, at no additional cost to owner.

1.09 JOB SITE CONDITIONS:

A. Do not store or begin installation of acoustical ceiling materials until:

1. All wet work such as concrete, plastering, and terrazzo is completed and thoroughly dried.

2. Building has been enclosed to the weather and suitable mechanical ventilation is supplied to maintain conditional ranges to 60° F to 85° F at not more than 70% relative humidity. Maintain these conditions at least 48 hours prior to installation, and during and after installation. Store panels/tiles in a clean, dry space where maximum temperature does not exceed 85° F and humidity does not exceed 70%.

3. Dust generating activities have terminated.

4. Overhead work such as mechanical, electrical, fire protection, etc., is completed. tested and approved.

B. Comply with published job conditions recommendations of CISCA Handbook.

PART 2 - PRODUCTS

2.01 ACOUSTICAL MATERIALS:

A. Acceptable Manufacturers, Acoustical Materials in all areas except Toilet Rooms:

1. Armstrong, Fine Fissured Humigard Plus.

B. Acoustical Materials: Beveled Tegular Edge, 24 x 24 x 5/8" and 24 x 48 x 5/8" as shown on drawings.

C. Toilet Rooms shall be 24 x 24 x 3/4" tegular edge Ceramaguard or USG Sheetrock Panel Clima Plus.

2.02 SUSPENSION SYSTEMS:

A. Acceptable Manufacturers, Suspension System

1. Armstrong

2. Donn Products/USG Interiors

B. Suspension System Materials shall conform to ASTM C635.

1. Attachment Devices: Type Recommended by suspension system manufacturer for attachment or anchorage of ceiling hangers to structure above ceiling, sized for not less than five times the hanger design load for the structural classification indicated.

2. Intermediate Duty.

3. Non-Rated Suspension System:

a. Grid #1 Components: Roll-formed double web steel tee construction pursuant to ASTM C635 for direct hung installation with main and cross tees carrying capacity of 12 lb./lin. ft.. Continuous exposed bottom flange design with unbroken roll-formed aluminum caps running full length of member.

b. Grid Color: White and match the tile. Off white is *not* acceptable.

c. Wall Molding: Angle, 15/16" with aluminum cap.

d. Wall Molding Color: White.

2.03 SUPPLEMENTAL MATERIALS:

A. Anchoring Devices:

1. Hot-dipped galvanized steel, ASTM A153, Coating Class C and D, screws, bolts, rods, hooks and eyes, and other devices designed for attachment to various types of structural framing systems, including system indicated, for support of ceiling suspension system.

2. Provide tested and certified carrying and pull-out capacities, for each device, for not less than five times the design load in ASTM C635, Table 1, Direct Hung installations.

B. Hanger Wire: Not less than 12 gauge, ASTM A641 soft temper, Class 1 coating.

PART 3 - EXECUTION

3.01 INSPECTION:

A. Examine areas to receive materials for conditions which will adversely affect installation, Provide written report of discrepancies with copies to Contractor and Architect.

B. Do not start Work until satisfactory conditions are corrected. Application for installation of materials constitutes acceptance of supporting construction.

C. Work to Be Concealed: Verify Work above ceiling suspension system is complete and installed in manner which will not affect layout and installation of suspension components.

3.02 PREPARATION:

A. Field Dimensions: Certify ceiling layouts by actual field dimensions prior to installation.

B. Verify actual location of items penetrating ceiling system with approved coordination Drawings.

3.30 INSTALLATION, DIRECT HUNG CEILING SUSPENSION SYSTEM:

A. Pursuant to ASTM C636, CISCA published recommendations, and applicable code requirements in force at time of installation.

B. Pursuant to manufacturer's published instructions, where more stringent than referenced standards specified, or where procedure is not covered by referenced standards.

C. Allowable deflection of main runners and cross runners is limited to 1/360 of the span between supports pursuant to ASTM C635.

D. Furnish hanger clips, and coordinate their installation., during erection of steel floor deck.

E. Support system independent of walls, columns, ducts, pipes, and conduit. Maintain face plane with adjacent members, when splicing carrying tee's.

F. Use properly placed and suspended load carrying framing channels to maintain hanger spacing and vertical position when interrupted by mechanical ducts and other horizontally run equipment.

G. Center suspended grid on room axis to allow equal border units, with no units less than one-half width unless otherwise shown on Drawings.

H. Provide top mounted cross-locking spacer bars for linear installations.

I. System Loads: When weight of components supported on main runners or cross runners causes total dead load to exceed deflection capability, provide additional hangers located

within 6" of each corner, unless otherwise recommended by manufacturer, or support components independently..

J. Do not apply system loads that may result in rotation of runners. Cross tees supported by main tees to have identical load carrying capacities of main tees.

K. Install wall molding at intersection of ceiling and vertical surfaces, using longest practical lengths. Firmly secure moldings to walls with corners neatly mitered.

L. Where circular or radius penetrations occur, provide preformed closures to match edge moldings.

M. Install expansion joint devices pursuant to manufacturer's recommendations.

3.04 INSTALLATION, LAY-IN CEILING PANELS

A. Install acoustical ceiling materials pursuant to manufacturer's published instructions, including the following:

1. Fit acoustic units in place, free from damaged edges, soiled surfaces, of other defects detrimental to appearance and function.

2. Lay directional patterned units in way with pattern parallel to longest room axis, unless otherwise shown.

3. Fit border panels neatly against abutting surfaces.

4. Install acoustic units level, in uniform plane, free from twist, warp and dents.

3.05 TOLERANCES: Maintain tolerances specified in ASTM C635 and C636.

3.06 CLEANING AND PROTECTION:

A. Upon completion of the work, remove all unused materials, debris, containers and equipment from the project site. Clean and repair floors, walls, and other surfaces that have been stained, marred, or otherwise damaged by Work under this Section.

B. Protect acoustical ceilings during the construction period so that they will be without any deterioration or damage at the time of acceptance by Owner.

• END OF SECTION •

SECTION 09920

PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Work required under this Section consists of all necessary services, tools, equipment, material and labor required to do all painting work called for, scheduled or reasonably implied by the Drawings and/or by these Specifications.

B. This Contractor shall examine the Specifications and shall thoroughly familiarize himself with all provisions regarding painting; he shall understand that all surfaces that are left unfinished by the requirements of other Sections shall be painted under this Section. This Contractor shall understand that all work specified under this Section shall be in addition to shop and mill coats, priming and field coats specified in other Sections.

C. This Contractor shall do all touching up of shop coats and field coats of paint on structural steel and miscellaneous steel or iron as required and specified.

D. Paint, Painting, Painting Work: As used herein, the term(s) shall mean all coating systems not specifically described in other Sections of these Specifications or which are not explicitly excluded from this Section, including primers, emulsions, enamels, sealers, fillers and finishing coats.

E. Paint all exposed surfaces whether or not materials are designated in "schedules" except where unfinished "natural" finish of material is obviously intended or specifically noted as surface not to be painted. Where items are surfaces not specifically mentioned, paint these the same as adjacent similar materials or areas. If color or finish is not designated, the Architect will select such from standard colors available for materials systems specified.

F. Items to be painted include, but are not limited to:

1. Galvanized metal exposed to view.

2. Work referenced in this Scope and in the Painting Schedule of these Specifications.

3. Grilles and vents which occur indoors (except aluminum).

4. Miscellaneous metals, such as ladders, access doors.

5. Cement plaster aluminum joint moldings and trim.

6. Exposed piping and conduit. See Mechanical for additional painting instructions.

7. Pipe hangers shall be galvanized.

1.02 WORK NOT INCLUDED IN THIS SECTION: Following categories of work are not included as part of painter-applied finish Work:

A. Pre-finished Items: Except where specifically called for otherwise, do not include painting when factory-finishing or installer-finishing is specified for such items (but not limited to): toilet partitions, acoustical materials, finished mechanical and electrical equipment such as light fixtures, panels, switch gear, motors, pumps, air handling equipment and the like.

B. Concealed Surfaces: Unless otherwise specifically called for, painting is not called for on surfaces above ceilings, behind wall or partition surfacing, nor in inaccessible areas, foundation spaces and duct shafts.

C. Finished Metal Surfaces: Finished metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze and similar finished metal materials will not require finish paint.

D. Operating Parts: Do not paint any moving parts of operating units, mechanical, and electrical parts such as valve and damper operator, linkages, sinkages, sensing devices, motor and fan shafts. Do not paint over fire labels, code required labels, equipment identifications, performance ratings, name or nomenclature plates.

E. Paint ferrous metal supports for fire sprinkler work. Do not paint pipework under this Section.

1.03 QUALITY ASSURANCE:

A. No lead or mercury shall be present in the products used.

B. All products used shall have a VOC (volatile organic compound) concentration of less than 250 grams per liter.

C. All work performed using the materials specified herein shall conform to all limits, data, and provisions of the MSDS sheets of the products being used.

D. This Contractor shall remove and redo or otherwise correct in a manner approved by Architect all work under this Section which peels, crazes, blisters, fails to adhere or otherwise fails to properly serve its intended purpose at no additional cost to the Owner.

E. This Contractor shall be wholly responsible for finish appearance and satisfactory completion of the Work under this Section. therefore, he shall not begin painting work until surfaces and environmental conditions are satisfactory. Commencement of painting Work shall imply acceptance of surfaces and environmental conditions. If such surfaces or conditions are not satisfactory, this Contractor shall notify the Contractor in writing. Nothing in these Specifications shall be considered as implying less work or lesser number of coats than necessary to produce first quality Work, and, in event a greater amount of Work or more costs are required than mentioned in these Specifications, this Contractor shall provide such at no additional cost to the Owner.

F. Comply with recommendations of the following national trade organizations who promulgate standards of workmanship:

1. The Steel Structures Painting Council: Good Painting Practices Manual

2. Painting & Decorating Contractor Association's Specification Manual

3. National Paint & Coatings Association's Painting Practices

G. All materials mentioned in these Specifications are intended to be the manufacturer's "first line" (consumer). If reference of a product appears to be other than the intent of the above sentence, notify the Architect in writing requesting clarification. If such notification occurs earlier than 10 days prior to bid opening, a written addendum will be issued if Architect

determines the notification is valid.

H. All materials not otherwise specified shall be the manufacturer's best quality.

I. Manufacturer's labels shall be read and complied with.

J. Except as may be specified otherwise, paint materials shall be applied only at temperatures above 50°. Comply with more exacting temperature range for each particular paint material as recommended by the manufacturer.

K. Comply with the minimum Dry Film Thickness for each entire system of paint materials based upon multiple thin coats rather than fewer thicker coats.

L. Provide undercoat paint material produced by same manufacturer as that of finish coat materials. Use only thinners recommended by paint manufacturer and only within recommended limits.

1.04 DELIVERY AND STORAGE:

A. Deliver all materials to job site in original, new and unopened packages and containers bearing the manufacturer's name label.

B. Provide labels on each container (or separately) with the following information:

1. Name or title of material.

2. Federal Specification number, if applicable.

3. Manufacturer's stock number.

4. Manufacturer's name.

5. Thinning instructions.

6. Preparation instructions.

7. Application instructions.

C. Store materials in safe, dry area adequately protected against fire, explosion or other damage which may be caused by paint materials. Good housekeeping practices shall be enforced.

D. A lockable area or room shall be made available and used for storage of paint materials. Floors and other surfaces of this area shall be adequately protected from damage, and should materials be spilled or damage occur, this Contractor shall remedy such at his expense. Job site tinting, mixing and thinning shall be done in this area.

E. Rags, paint and solvent shall be stored in metal containers.

1.05 JOB CONDITIONS:

A. Inquire of and verify with manufacturer of labeled doors and labeled transom panels as to recommendations for preparations of planed, butt or trimmed surfaces as to coating such surfaces and adjacent surfaces with three coats of shellac (or other inhibiting coating

recommended by the manufacturer of the door) to prevent paint deterioration or discoloration due to chemical seepage at cut surfaces. Comply with door manufacturer's recommendation.

B. Do not apply solvent-thinned paints when temperature of surfaces to be painted and surrounding air temperatures are below 45° F.

C. Do not apply paint in rain, fog, or mists or when RH exceeds that previously specified; not to wet or damp surfaces. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated to temperature, RH and time parameters previously specified.

1.06 SUBMITTALS: Within 14 calendar days of Contract award submit:

A. Manufacturer's Data: This Contractor shall submit any emission/off-gassing indoor air quality data for the products used.

B. Before purchase of coating materials, provide to the Owner via the Project Architect, executed Guarantees and Warranties from the Manufacturers, or a letter from the Manufacturers agreeing to provide such Guarantees and Warranties.

C. The manufacturer's technical information and application instructions shall be submitted by the Contractor to the Project Architect for compliance with these Specifications.

D. Once the submittal or resubmittal is acceptable, the acceptable submittal shall be returned to the Architect, who will review it, voice his comments and concerns, and then return it to the Contractor.

E. The submittal shall identify by specification paragraph number and specific surface which product is submitted for consideration.

F. Samples:

1. The color shall be as selected by Architect.

2. This Contractor shall submit samples of each product to be used. Samples shall be properly dated and identified.

3. Samples are for review by Architect for color and texture only. Compliance with other requirements shall remain exclusive responsibility of this Contractor. The Architect shall have full authority to accept or reject colors and textures, without right of appeal by others.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Ready-mixed paints, varnish, stains, epoxies, waxes, and urethanes. Only the specific manufacturers listed in the pertinent paragraphs are approved, subject to compliance with these Specifications.

B. Thinners and additives shall be of types recommended by the paint manufacturer.

C. Putty Spackle:

1. Whiting: Class A

2. Acrylic

3. Vinyl Acrylic

D. Thinners: (Verify manufacturer.) Mineral spirits or the thinner recommended by the paint manufacturer.

2.02 COLORS:

A. Architect shall select all paint material colors and shades. Selection will be made from color system. This Contractor may use other specified manufacturers but shall submit matching chips or matching color samples to Architect's satisfaction.

B. The Contractor shall assume five interior colors.

2.03 COVERAGE, THICKNESS AND ADHESION:

A. Total minimum of each "painting system" for each group of primer, intermediate and finish coats is set forth in the "Painting Schedule" paragraphs for each type surface to which applied.

B. Such application shall be in sufficient coats to provide full opacity, but in no event shall be Dry Mil Thickness be less than specified herein.

C. In event in-place DFT is questioned, a suitable dry film thickness gauge of sufficient magnification shall be used for sample tests.

D. A 25 sq. ft. sample shall be installed on the actual substrate on the job site. This sample shall remain in place. The 25 sq. ft. paint color sample shall be allowed to dry 48 hours and then tested for adhesion on the actual substrate by using the test protocol as outlined in ASTM D3359. If the test indicates unsatisfactory adhesion, this Contractor shall determine what procedures are to be followed in the corrective action, and shall effect such corrective action.

E. Finished coating systems shall pass the ASTM D3359 Adhesion Test.

2.05 PAINTING SCHEDULE - INTERIOR COATING SYSTEMS

A. Interior surfaces fall into 9 groups for purposes of applying protective coatings in these Specifications. They are:

1. Interior galvanized metal

2. Interior ferrous metal

3. Interior non-ferrous metal

   a. Not pre-primed

   b. Pre-primed

4. Gypsum wallboard

5. Concrete block, interior

6. Finished quality wood doors, cabinet-work, casework, lumber, trim, hardwood plywood, wood paneling, and millwork - designated to be "transparent finish".

7. Other interior lumber finished with transparent finish.

8. Other interior lumber, wood trim, wood doors scheduled to be painted and overlay plywood to be finished with opaque finish

9. Concealed cabinet backs (and ends).

B. The number of coats set forth in the following paragraphs shall be considered the minimum number of coats required subject to coverage DFT, manufacturer's recommendations, or end results, necessitating a greater number of coats.

C. The surfaces to be coated under this specification, unless otherwise noted, shall be coated with two or more top quality coats of two-part Epoxy Acrylic Semi-Gloss Enamel, water thinned noted. Primer systems for each surface substrate are marked with appropriate primer.

D. Surfaces:

1. Interior galvanized metal: Thoroughly clean to remove grease, residue and corrosion products on surface with solvent or chemical washes recommended by and in manner recommended by paint manufacturer. Surfaces exposed to weather for a long period of time or showing rust shall be primed with a corrosion inhibitive primer and thoroughly clean prior to the following:

   a. One coat Acrylic Latex Primer.

   b. Two coats Acrylic Latex Exterior Gloss Enamel.

   c. Total minimum DFT, 4.5 mils.

2. Interior ferrous metal:

   a. Thoroughly clean by one of the ten surface preparation methods established by the Steel Structures Painting Council and published in Sherwin-Williams Painting Systems Catalog, as applicable, SSPC-Vix. 1-67T. Such shall be used as a basis for Visual Standards.

   b. One coat zinc chromate pigmented primer. (This coat is not required on

items delivered shop primed, but touch up is required.)

c. Two coats, Acrylic Latex Exterior Gloss Enamel.

d. Total DFT, 5 mils.

e. Structural steel, bar joists, miscellaneous metals:

(1) Concealed above ceilings, within walls or chases: Touch up only.

(2) Exposed in habitable spaces: Coat entire surfaces.

(a) Two coats Acrylic Semi-Gloss Enamel.

(b) Total DFI, 5 mils.

3. Interior non-ferrous metals:

a. Interior non-ferrous metals to be painted, (not pre-primed):

(1) Clean, as recommended by paint manufacturer.

(2) One coat Alkyd Enamel Undercoater.

(3) Two coats Acrylic Semi-Gloss Enamel.

(4) Total DFT 4.5 mils.

b. Interior non-ferrous metals to be painted (pre-primed):

(1) Two coats Acrylic Semi-Gloss Enamel.

(2) Total DFT, 3 mils.

4. Gypsum Wall Board:

a. See Job Conditions Paragraphs.

b. One coat Latex Drywall Primer (Scott #2-15).

c. Two coatsLatex Semi-Gloss Enamel (Scott #2-50).

d. Total DFT, 4.5 mils

PART 3 - EXECUTION

3.01 JOB CONDITIONS:

A. Apply coatings/paint when surface temperatures are in accordance with manufacturer's recommendation.

B. Do not apply paint in rain, fog, or mists or when RH exceeds that specified by the Manufacturer; nor to wet or damp surfaces. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated to temperature, RH and time parameters specified by the manufacturer.

3.02 INSPECTION:

A. A pre-commencement meeting regarding coatings/painting work shall be scheduled by the Architect shortly prior to the beginning of the coating/painting work, including the Contractor, a principal of the Coating/Painting Subcontractor's, the Owner and the Project Architect.

B. This Contractor shall examine the areas and conditions under which the painting is to be applied, and notify the Project Architect in writing of conditions detrimental to the proper and timely completion of this phase of the Work. Do not proceed with this phase until the unsatisfactory conditions have been corrected. Commencement of Work shall be construed as acceptance of the surface and environmental conditions.

C. The project Architect and/or the Owner shall have a fair opportunity to inspect each phase of preparation and painting. The Owner and Project Architect shall have the opportunity to inspect for general apparent compliance with the number of coats by inspecting each coat prior to the application of any additional coats, otherwise no credit shall be given for the coat in question and this Contractor shall, at no charge to the Owner, remove coatings/painting and/or recoat the surfaces. Forty-eight hours advance notification shall be given by the Contractor to the Architect prior to the required inspection.

D. Samples of coating may be periodically removed from unopened containers by the Project Architect and subjected to analysis. If product does not conform to standards set down by these Specifications the product will be removed from project, replaced, removed from any surface to which it has been applied and repainted with proper product, all at no expense to the Owner.

E. The Contractor and the Coating/Painting Subcontractor shall allow access to in-place scaffolding, ladders, lift equipment etc. for inspection by the Project Architect and the Owner.

3.03 PREPARATION FOR PAINTING/COATING - GENERAL:

A. Surfaces to be painted shall be clean, smooth, free from scratches and dust, thoroughly dry and well sanded (where appropriate) before painting work is started.

B. If trowel marks or other defects on gypsum plaster necessitate sanding the surface, follow by through washing and wiping with weak solution of phosphoric acid.

C. After the prime coat has been applied on wood surfaces, nail holes shall be filled with putty colored to match the finish. Putty shall be brought flush with the surface of woodwork and sanded.

D. Knots, sap and pitch streaks in lumber which receives a paint finish. Such shall be brush coated with shellac before the prime coat is applied.

E. Concrete and masonry surfaces shall be cleaned, grouted, rubbed and pointed prior to painting.

F. All exterior steel and aluminum surfaces: Remove oil, grease or other foreign matter by

solvent cleaning in accordance with SSPC-SP-2-63.

3.04 PREPARATION FOR NEW CONSTRUCTION: All requirements under Paragraph 3.03, Preparation For Painting/Coating - General, shall be adhered to.

3.05 PREPARATION FOR REFINISHING EXISTING CONSTRUCTION:

A. All requirements under Paragraph 3.03, Preparation For Painting/Coating - General, shall be adhered to.

B. Existing coatings systems shall be permanently and satisfactorily adhering to substrates. The Painting/Coating subcontractor shall be responsible for the integrity of the substrate (for entire project) to accept the Paint/coating without failure of adhesion or delamination of previous coating. The subcontractor shall include an adequate sum in his bid proposal to do such work.

1. Adhesion of existing coating system shall be tested by the Painting/Coating Subcontractor in accordance with ASTM D3359 - Method A. Permacel #99 is the approved tape used in this test and is available from Paul N. Gardner Company, Inc., 316 NE First Street, Pompano, FL 33060, Phone: (305) 946-9454.

2. Completely remove any loose, non adhering coating system by appropriate means.

3. Grinding of loose coating on ferrous and non-ferrous metals will be necessary to accomplish complete removal of non-adhering coating systems.

4. A coating system for purposes of this Section is defined as all coats of paint or coatings which have been previously applied to a substrate. In old buildings or centers this system can be as many as 10 - 15 coats.

C. Feather edges of sound coating systems by grinding or sanding. No sharp edges will be allowed.

D. Patch any areas where paint removal procedure has damaged substrate. Patching material shall have positive adhesion and shall match texture or existing substrate. Patching material shall be of type and brand recommended by Paint/Coating Manufacturer.

E. Existing coating surfaces and other surfaces to be painted shall be washed to remove dirt, grease, mildew, oil, body oils (proteins), or other foreign material.

1. Washing solution shall be one pound TRI Sodium Phosphate per four gallons warm tap water.

2. Use a soft bristle brush to scrub all surfaces.

3. Thoroughly rinse with tap water to remove all residue for washing procedure. This will require multiple rinses.

4. Extra care shall be taken on all hand rails, lockers, areas within 18 inches of blackboards, and within 18 inches of all door knobs and door push plates. This includes door frames adjacent to door locksets, knobs, push plates, and other finish hardware.

5. Thoroughly clean exterior wall surfaces with pressure equipment spraying water at a pressure of 1,800 psi minimum. Pressure shall be measured at spray apparatus tip. Water shall contain a detergent and bleach. Washing shall be followed by rinsing with same equipment, using tap water.

F. All existing gloss surfaces to be recoated, as described in these Specifications and Drawings, shall be de-glossed. All de-glossing shall be accomplished by use of sandpaper or steel-wool. Hand or mechanical sanding will be used.

1. No marks or gouges by sandpaper will be allowed.

2. Remove dust caused by sanding and steel wooling with clean, damp, soft cloth. Allow to dry. A uniform flat surface shall result when viewed at a 20° angle.

3. No liquid substitute for sanding will be allowed.

G. Paint and coating selection will be as described in Paragraphs 2.05, 2.06 and 3.01 of this Specification.

3.06 PROTECTION:

A. Fixtures and hardware shall be removed or protected during the painting operation.

B. This Contractor shall take particular care by use of clean drop cloths, masking and other suitable means, to protect adjoining surfaces, fixtures and materials of all kinds, and shall be held responsible for and shall repair or replace any damaged work resulting from painting operations.

3.07 APPLICATION:

A. When applying block filler, masonry surface primers, stucco and gypsum board primer by spray application, back rolling is required.

B. When a roller used, the roller nap size shall be appropriate for the existing surface condition, porosity, and finish in a manner to assure a smooth, uniform finish will result.

C. Metal primers shall be applied by brush.

D. Quality of finish:

1. Specified gloss of top coats shall be uniform and shall be applied in a manner which will not show differences in gloss or appearance finish when viewed at a 20° angle with a light source at far end of surface being viewed.

2. Dry film thickness (DFT) will be uniform throughout surface being painted.

E. Adhesion of entire paint system shall pass a tape pull from a cross hatch cut as described in ASTM D3359.

F. Block filler shall be applied in a manner to fill all holes and pores of concrete block. This is possible with specified block fillers when manufacturer's instructions are followed.

G. Apply paint/coating evenly spread and well rolled or brushed. The finish coats shall be free from noticeable laps, brush marks, streaks, runs, sags, wrinkles or shiners.

H. Such shall be provided in two coats (minimum) to provide full opacity, but in no event shall the total coating be less than 1.5 mil DFT.

I. Sand pertinent surfaces thoroughly prior to first coat and between following coats as required for first class finish.

J. Tools for particular coatings application (i.e. spraying, rolling, back rolling, brushing) shall be such that specified results will be achieved.

3.08 TOUCH-UP AND CLEANING

A. Upon completion, touch-up required. Painting/Coating shall be removed from surfaces which are not specified to receive paint/coating.

B. If touch up is of top coat of paint, color difference when viewed at 90° and 20° shall not be acceptable.

C. If entire wall or surface area involved needs to be recoated to insure color blending, it shall be recoated.

3.09 WASTE DISPOSAL: At the end of each day, properly dispose of all materials including cloths and waste materials, which have been used in preparation and application of paint materials. Comply with requirements of Federal, State and Local regulatory agencies including DER, EPA and Pinellas County Department of Environmental Control. Under no circumstances shall this Contractor empty his waste in plumbing fixtures, drains or cleanouts of the plumbing systems of the building.

• END OF SECTION •

DIVISION 23—HEATING, VENTILATING, AND AIR CONDITIONING

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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Basic mechanical requirements specifically applicable to Division 15 Sections, in addition to Division 1—General Requirements, General Conditions and Supplementary General Conditions.

B. This Division of the specifications includes mechanical;

1. Heating, Ventilating, Air Conditioning (HVAC).

2. Plumbing, and that mechanical which applies to heating, ventilating, air conditioning, and plumbing.

1.2 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

C. The term “Basis of Design” used throughout this document shall be understood to mean a particular manufacturer’s equipment (as scheduled specifically on the drawings or specifications) has been used as the basis by the Design Engineer to establish physical dimensions, quality, and performance required, in addition to providing a basis for interaction with other ancillary components and/or other trades. Therefore, it shall be understood that use of a piece of equipment other than that identified as the Basis of Design may impact performance of an overall engineered system or may require revisions to ancillary interfacing equipment, and thus any manufacturer’s equipment other than that listed as Basis of Design shall require written approval via Addendum prior to bid except where the manufacturer’s name is specifically listed in these specifications as a pre-approved substitute or an accepted manufacturer. All substitutes, pre-approved substitutes, accepted manufacturers, and/or Basis of Design are subject to all requirements of quality, physical characteristics (i.e., dimension, sound, etc), and performance, etc., as set forth in these specifications and contract documents.

1.3 SURVEYS AND MEASUREMENTS

A. Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work. All material take-offs for the site shall be field measured prior to bids.

1.4 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. Drawings are not to be scaled. The architectural drawings and details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Architect.

B. If directed by the Architect or Engineer, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. At the time of each shop drawing submission, the Contractor shall call the Engineer's attention (in writing) to, and plainly mark on shop drawings, any deviations from the Contract Documents. (See Paragraph 1.06, B.)

D. Samples, drawings, specifications, and catalogs submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, location, section and article number of specifications governing, Contractor's name, and name of job. All equipment shall be labeled to match labeling on contract documents.

E. Control Systems: Submit description of operation and schematic drawings of the entire control system. Include bulletins describing each item of control equipment or component.

F. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

G. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specifications.

H. All shop drawings shall be submitted to the A/E by Contractor no later than 30 days from the day of contract award.

I. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

J. Submit all Division 15 submittals at one time in one integral group. Piece-by-piece submission of individual items will not be acceptable. Engineer may check contents of each submittal set upon initial delivery; if not complete as set forth herein, submittal sets may be returned to Contractor without review and approval and will not be accepted until made complete.

K. Routing and methods of support of piping shall be shown on shop drawings and shall have the review of the Engineer prior to fabrication and installation. Spacing of supports shall be as specified in Section 15140, or if not specified, shall not exceed the suggested maximum spacing recommended in ANSI B31.1 for each type of line. Supports shall be fabricated as detailed on reviewed shop drawings. Provide supports so located that temporary supports are not required during removal of valves or equipment. Insofar as possible, support lines directly from Building structure.

L. At the close of the job, prior to final review, five (5) bound copies of the following shall be submitted by transmittal letter to the Engineer for review and acceptance:

1. Equipment warranties;

2. Contractor's warranty;

3. Parts list and manuals for all equipment;

4. Balance and test readings;

5. Operating instructions (in writing);

6. Written instructions on maintenance and care of the system.

1.5 SUBMITTALS

A. Submit Manufacturer's published technical data, catalog cuts, wiring diagrams, shop drawings, samples and testing and balancing logs for all elements of the HVAC work. Submit under provisions of General Conditions and Supplementary General Conditions.

B. No equipment, piping, ductwork or components shall be fabricated, delivered, erected, or connected other than from shop drawings reviewed and approved by the Engineer.

C. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

D. Equipment Supports: Submit detailed shop drawings indicating equipment weight and dimensions, support material, connections, anchoring, and vibration isolation.

E. Submittals shall include, but not be limited to the following:

1. All equipment; cooling, heating, plumbing, electrical motors, starters, controls, etc.

2. Voltage, phase, and amps of each electrical item, such as motors, etc.

3. All auxiliary equipment.

4. Pipe, ductwork, valves, insulation, etc.

1.6 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Mechanical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed below equipment indicated as “Basis of Design” shall be considered as substitutes. Manufacturers other than the Basis of Design shall submit catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute. The comparative shall list capacities, pressure drops, horse power, electrical requirements, etc., (refer to Paragraphs 1.04.C and 1.06.C).

Request for approval of substitutions shall be made in writing no less than ten (10) days (unless otherwise directed in Division 1) prior to bid. Substitutions shall not be considered approved unless the approval appears in an Addendum or unless so named in the specifications as a pre-approved substitute. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

C. All requests for substitutions shall be submitted as described in paragraph 1.06, B., and specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution. Differences shall include, but shall not be limited to, data as follows for both the specified and substituted products.

- Principle of operation;
- Materials of construction or finishes;
- Thickness or gauge of materials;
- Weight of item;
- Deleted features or items;
- Added features or items;
- Changes in other Contractor's work caused by the substitution;
- Physical dimensions;
- Electrical requirements.

D. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

E. Where such approved deviation requires quantity and arrangement of ductwork, piping, wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

1.7 COOPERATION WITH OTHER TRADES

A. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

C. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.8 PROTECTION

A. Protect all work and material provided under this Division from damage. All damaged equipment work or material provided under this Division shall be replaced with new. Re-builts are not acceptable.

B. Protect all work and equipment until inspected, tested, and accepted. Protect work against theft, injury, or damage; and carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.9 SCAFFOLDING, RIGGING, AND HOISTING

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

1.10 REMOVAL OF RUBBISH

A. This Contractor shall at all times keep premises free from accumulations of waste materials or rubbish caused by his employees or work. At completion of work he shall remove all his tools, scaffolding, materials, and rubbish from the building and site. He shall leave the premises and his work in a clean, orderly, and acceptable condition.

B. All plaster, concrete, cement, etc. shall be removed from all pipe, hangers, and equipment prior to painting and/or concealment.

1.11 SAFETY

A. This Contractor shall comply with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.333), Title 29—Labor, Chapter XIII, Bureau of Standards, Department of Labor, Part 1518—Safety and Health Regulations for Construction; and that his housekeeping and equipment be maintained in such a manner that they comply with the Florida Industrial Commission Safety Code and Regulations of the Federal Williams—Steiger Occupational Safety and Health Act of 1970 (OSHA), wherein it states that the Contractor shall not require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

1.12 SUPERVISION

A. This Contractor shall provide a competent, experienced, full time superintendent who is acceptable to the Architect/Engineer and Owner, and who is authorized to make decisions on behalf of the Contractor.

1.13 LUBRICATION

A. Where necessary, provide means for lubricating all bearings and other machine parts. If a part requiring lubrication is concealed or inaccessible, extend a lubrication tube with suitable fitting to an accessible location and suitably identify it.

B. After installation, properly lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.

1.14 VALVE CHARTS, TAGS, AND NAMEPLATES

A. Provide at a location designated by the Engineer and the Owner, a valve chart enclosed in an aluminum frame with clear plastic shield. Chart shall show the designated number of each valve, its location and service. Valve numbers shall be same as those shown on the "As-Built" drawings.

B. Each valve shown on the chart shall have a 1-1/2" diameter, 18 gauge brass tag with clearly visible stamped numbers, securely fastened to the valve stem or handle with a heavy brass hook or chain.

C. Each panel mounted switch, thermometer, gauge, or controller for fans, pumps, or other electrically operated equipment shall be clearly designated by a black plastic nameplate of size approved by the Engineer securely fastened with metal pins or screws to the panel directly under the item designated.

D. Refer to Section 15190 for additional information.

1.15 WIRING DIAGRAMS

A. Furnish for use under Division 16 all wiring diagrams as may be required for the installation of the wiring to insure proper operation and control of the equipment provided under this Division. Provide the diagrams in time to avoid delays.

1.16 MATERIAL AND WORKMANSHIP

A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Engineer shall be furnished. Refer to substitutions in this Section.

B. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed with the approval of the Architect and Engineer in accordance with the recommendations of the Manufacturer. This includes the performance of such tests as the Manufacturer recommends.

1.17 QUIET OPERATION AND VIBRATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer and the Owner. In case of moving machinery, sound, or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer and the Owner shall be corrected in an approved manner at no additional expense to the Owner. Vibration control shall be by means of approved vibration eliminators in a manner as specified in Section 15242.

1.18 ACCESSIBILITY

A. This Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all other Contractors whose work is in the same space, and shall advise them of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

B. This Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to, valves, traps, clean-outs, motors, controllers, switchgear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

C. This Contractor shall provide the access panels for concealed mechanical equipment, valves, controls, dampers, or other device requiring service. (Refer to Paragraph 1.20 of this section.)

1.19 FOUNDATIONS, SUPPORTS, PIERS, AND ATTACHMENTS

A. This Contractor shall furnish and install all necessary foundations, supports, pads, bases and piers required for all air conditioning equipment, piping, pumps, tanks, compressors, and for all other equipment furnished under this Division, and shall submit drawings to the Architect and Engineer for approval before purchase, fabrication or construction of same.

B. For pumps, compressors, and other rotating machinery, and for all equipment where foundations are indicated, provide concrete pads as shown. All pads shall be extended six inches (6") beyond machine base in all directions with top edge chamfered. Inset six inch (6") steel dowel rods into floors to anchor pads. All pads shall have a minimum of 6 x 6 W2.9/W2.9 WWF unless otherwise noted. Shop drawings of all foundations and pads shall be submitted to the Architect and Engineer for approval before same are constructed.

C. Construction of foundations, supports, pads, bases, and piers where mounted on the floor, shall be the same materials and same quality of finish as the adjacent and surrounding flooring material.

D. All equipment, unless shown otherwise, shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect and the Engineer, not strong enough shall be replaced as directed.

1.20 ACCESS DOORS FOR WALLS AND CEILINGS

A. Provide flush panel access doors with a 16 gauge steel frame and a 14 gauge steel door panel.

B. Finish is to be primed painted steel.

C. Provide concealed hinges which allow the door to open 175 degrees and have a removable pin.

D. Provide access doors with a locked flush mounted vandal proof spanner head operated steel cams.

E. Provide 1-1/2 hour "B" label door for rated chase walls.

F. Furnish masonry anchors for installation in masonry walls and metal lath wings with casing bead for plaster installation.

G. Provide a minimum 2'-0" by 2'-0" access doors unless shown or noted otherwise on the drawings.

H. Access doors for chase walls shall be mounted 16" off the finish floor.

I. Access doors for mechanical equipment shall be a minimum of 12" larger than equipment all around.

1.21 VALVE BOXES

A. All exterior underground valves shall be provided with exterior valve boxes equipped with removable covers appropriately labeled.

B. Valve boxes shall be manufactured of reinforced fiberglass plastic or heavy duty PVC as approved by the Architect/Engineer, unless otherwise noted on the drawings.

1.22 WELDING

A. Welded pipe joints shall be made by the oxyacetylene or electric process in accordance with the Code of Pressure Piping ASA B31.1.

B. Welding shall be done with good quality modern welding equipment, by competent operators, and in thorough, first class manner, conforming to AWS Standards.

C. The Contractor shall be required to furnish proof of the competency of each welding operator for both field and shop welds and shall at the request of the Architect/Engineer have all or any of such welding operators pass a standard qualification test such as ASME, AWS, or Hartford Insurance Company procedure and tests.

D. Filler-metal for the welding process shall conform to ASTM A233 "Specification for Mild Steel Arc-Welding Electrodes". Classification of electrodes shall be one of the following: E6010, E6015, E7016, E7018.

E. When welding is to be performed, precautionary measures must be taken to prevent fire. Remove flammable materials and debris from the area. Provide an appropriate extinguisher nearby.

F. Pipes shall be cut short and cold sprung into place before welding or fabricating to compensate for expansion of lines when hot.

G. Welds shall be of the single vee butt type. Pipe end shall be shop beveled to 45 degrees to within 1/16 inch of the inside wall surface.

H. The abutting ends of the joints shall be separated before welding to permit complete fusion, tacked in two or more points to maintain alignment, and welded. Welding shall be continuous around the pipe.

I. Welds shall be of sound weld metal, thoroughly fused into the ends of the pipe and to the bottom of the vee, and shall be built up in excess of the pipe wall to give a reinforcement of one-quarter (1/4) the pipe wall thickness and in such a manner that one weld metal will present a gradual increase in thickness from the surface of the pipe to the center of the weld. The minimum width of the weld shall be 2-1/2 times the pipe wall thickness.

J. The fillet welds from the flanges of fittings shall be fused into the pipe and plate for minimum distance of 1-1/2 times the pipe wall thickness and shall be built up to present a minimum throat thickness of depth of weld of 1-1/4 times the pipe wall thickness.

K. Branch connections shall be fabricated by welding. Openings cut into pipe for welded connections shall be accurately made to give carefully matched intersections and welding fittings shall be carefully welded into the pipe system.

L. Welding ells shall be used at all turns in welded pipe lines; no mitered ells will be approved.

M. Where branch piping is three times smaller than the main, branch connections shall be made up with the appropriate manufactured weld-on fitting. Welded tees shall be used for all other branch connections, unless otherwise approved by the Architect/Engineer for a specific case.

1. Approved Manufacturers

a. Allied Piping Products.

b. Bonney Forge.

c. Branch Connections.

d. Branchlets.

e. Tube Turn.

f. Thread-O-Lets.

N. Welds in piping shall be annealed after welding to remove the welding strains. The temperature need not exceed that causing a dull red, and shall be uniform around the pipe. Welds made in place shall be annealed, but the pipe shall be free to expand and shall be properly supported so as to avoid stresses. Annealing shall always be followed by slow cooling.

1.23 REGULATORY REQUIREMENTS

A. Conform to applicable Codes and Standards as follows:

1. Standard

a. Certain standard materials and installation requirements are described by reference to standard specifications. These standards are as follows:

ASA ..... American Standards Association.

ASTM ..... American Society for Testing Materials.

ASME ..... American Society of Mechanical Engineers Code of Unfired Pressure Vessels.

NEMA..... National Electrical Manufacturers Association.

UL ..... Underwriters Laboratories.

ANSI..... American National Standards Institute.

ASHRAE ..... American Society of Heating, Refrigerating and Air Conditioning Engineers.

SMACNA..... Sheet Metal and Air Conditioning Contractor's National Association.

AMCA..... Air Moving and Conditioning Association.

ARI ..... Air Conditioning and Refrigeration Institute.

AMA ..... Acoustical Materials Association.

For additional standards and requirements see other sections of the specifications.

Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition at the time project is bid unless otherwise specified herein.

2. Codes And Rules

   a. All material furnished and all work installed shall comply with the following codes as they apply to this project:

      - ❍ National Electric Code.
      - ❍ Regulations of the Florida Industrial Commission Concerning Safety.
      - ❍ Applicable County, State and Local Building Codes.
      - ❍ Local and State Fire Marshal Rules and Regulations.
      - ❍ Occupational Safety and Health Agency Standards (OSHA).
      - ❍ Florida State Board of Health Rules and Regulations.
      - ❍ Florida Building Code—Mechanical.
      - ❍ Chapter 4A-47, Florida Administrative Code - Uniform Fire Safety Standards for Elevators.
      - ❍ State Requirements for Educational Facilities (SREF), Chapter 4, Section 423, of the Florida Building Code.

      Applicable codes shall be those adopted by the authority having jurisdiction at the time project is bid.

3. Permits, Fees And Inspections

   a. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all necessary approvals of all governmental departments having jurisdiction.

   b. Obtain all required certificates of inspection for his work and deliver to the Owner/Engineer the same certificates before request for acceptance and final payment for the work.

   c. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

d. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.24 SCOPE OF WORK

A. The scope of the work included under this Division of the Specifications shall include complete mechanical systems as shown on the plans and as specified herein. The General Conditions and Special Conditions of these specifications shall form a part and be included under this Section of the Specifications. Provide all supervision, labor, material, equipment, machinery, plant, and any and all other items necessary to complete the mechanical systems. All items of equipment are specified in the singular; however, provide and install the number of items of equipment as indicated on the drawings, and as required for complete systems.

B. Systems shall include all appurtenances as required to achieve the operating conditions as shown and specified and shall result in a superior installation.

C. Scope of work shall include, but not be limited to, the following:

1. New Work

a. Provide chillers, boilers, pumps, air handling systems, fan coil units, and split system DX units, complete with coils, filters, variable volume boxes with heating coils, ductwork, controls, etc.

b. Provide a new building management and automatic temperature control system.

c. Insulate all new chilled water, heating and domestic hot water piping. Insulate all new and existing equipment with exposed hot and cold surfaces.

d. Provide sanitary and roof drainage systems as shown on drawings.

e. Provide gas, domestic hot and cold water system as shown on drawings. Provide new water heaters where indicated on drawings.

f. Provide new plumbing fixtures where indicated on drawings.

g. Provide final connections of ductwork and piping (domestic, chilled, make-up, and hot) to equipment and plumbing fixtures.

h. Provide testing and balancing of all air and water systems.

D. All electrical work required to support mechanical equipment or is otherwise necessary to operate mechanical equipment, shall be the responsibility of the Mechanical Contractor (including, but not limited to) electrical motors for all motor-operated equipment required under this Division, motor controllers, all starters not provided by the Electrical Contractor (coordinate with Electrical Contractor), pilot lights and relays, line and low voltage control wiring, raceways, connections to switches, and other electrical devices furnished with temperature control systems except as otherwise provided for in other Divisions of this Specification.

E. All starters furnished by the Mechanical Contractor shall meet all requirements specified.

F. Any equipment submitted for prior approval shall be submitted with the following written information specifically for the submitted project application: specific model numbers, dimensional data, performance data and other data as requested by the Engineer. General or ambiguous submittals will not be considered for prior approval.

1.25 REMOVALS, RELOCATIONS, RECONNECTIONS, AND RESTORATIONS

A. Demolition of existing piping, equipment, etc., shall be done as indicated on the Drawings. Existing piping and/or equipment to be removed shall be offered to the Owner. If the Owner wishes to utilize the existing equipment elsewhere, this Contractor shall move the equipment to a site designated by the Owner. All material to be removed shall be discarded by the Contractor and they shall not be used again.

B. All demolition work shall be completely coordinated with the Owner. Demolition and reconnections requiring shut-down of existing systems shall be scheduled with the Owner/Engineer. If shut-down can only be accommodated on the weekend, or after normal working hours, such work shall be done at no additional cost to the Owner. If it is not possible to schedule sufficient Owner coordinated and approved downtime to complete the entire demolition and reconnection scope such that all or a part of the facility's service(s) will be disrupted, affecting the normal business operation of the facility (i.e., loss of HVAC or plumbing), the Contractor shall provide temporary accommodations (i.e., temporary HVAC or portable toilets, etc), for the duration of the shutdown at no additional cost to the Owner.

C. Location, capacity, size, etc. of existing equipment, piping, etc., was obtained from field survey and as built drawings. Verify all conditions at site prior to commencing with work. Notify Engineer of any discrepancies prior to starting work or ordering material.

D. Survey existing facilities and utilities as necessary to determine location of shut-off or disconnect devices, drains, vents, etc. Drain, refill, and purge existing water piping circuits to make new piping connections. It is the Contractor's responsibility to verify the existing piping and identify which is supply and return, chilled water, and hot water, prior to starting demolition for new piping connections.

E. Temporarily store all items to be relocated, if required. Contractor shall be responsible for safe storage of all such items and shall replace any items lost or damaged during storage removal or reinstallation.

1.26 PROJECT/SITE CONDITION

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Owner/Engineer before proceeding.

1.27 TRENCHING AND BACKFILLING

A. For requirements for trenching and backfilling, refer to Division 2.

1.28 CLOSE-OUT DOCUMENTS

A. This Contractor shall furnish Operating and Maintenance (O&M) manuals and As-built drawings before final payment will be issued.

1. O&M manuals shall be submitted in accordance with Division 1, General Requirements, and shall consist of the following (at a minimum):

a. All Contractor and Manufacturer warranties.

b. List of Contractors and Parts and Equipment Suppliers—complete with contact person, proper company name, address, and telephone numbers.

c. Parts list for supplied equipment—including a checklist of recommended components to be stocked on-site.

d. Maintenance and replacement parts manuals.

e. Start-up and shutdown operating instructions.

f. Manufacturer's literature describing the equipment, which shall include wiring diagrams and operating specifications.

g. Control system sequence of operation, system diagram, and backup disks of the system configuration.

h. Copies of final test and balance reports.

2. The Contractor shall provide AutoCAD as-built drawings and copies of each AutoCAD file on CD before final payment will be issued.

1.29 EXISTING CONDITIONS—EQUIPMENT AND SYSTEMS

A. For purposes of this Contract, the assumption during bidding is that any and all existing fire alarm, intercom, security, lighting, electrical systems, etc., are complete and operating properly.

B. Before commencing any work on fire alarm, security alarm, energy management, intercom, lighting, or electrical systems, or any work which affects them, the Specialty Contractor shall examine such systems thoroughly. If this Contractor finds any portion of any system not functioning fully and properly, he shall notify the Project Architect/Engineer (PA/E) and the Owner in writing exactly and precisely which item(s) are not working. (This paragraph does not require diagnosis as to why such item(s) are not working nor the repair of such.)

C. Upon notification to the Owner, the PA/E and Owner shall verify whether such report is accurate. If found not accurate, the PA/E and the Owner shall demonstrate such to this Contractor. If the report is found accurate, the Owner may either:

1. Correct such deficiencies with his own Maintenance forces or by employing another Specialty Contractor.

2. Require of the Contractor for this construction project a proposal sum to thoroughly diagnose the cause of such deficiencies and the specifying of precise corrective action needed.

3. Upon receipt of such proposal sum, the Owner may elect to employ the Contractor, by Change Order, to effect such corrections; or, with the Contractor's approval, employ the Contractor's appropriate Specialty Contractor directly by Purchase Order, to effect such corrections; or the Owner may achieve corrections to the system by other means.

D. However, upon commencing any work under this Contract on fire alarm, security alarm, energy management, lighting, intercom, or electrical systems under this Construction Contract, this Contractor has accepted the systems as complete and functioning properly. From the time of commencing work on such systems, they become the responsibility of this Contractor to maintain and keep functional through the Date of Final Substantial Completion. If, at the time of Final Substantial Completion, such a system or portion of such system is found not to be functioning properly, such item shall be listed on the "punchlist" and shall be corrected by this Contractor. Once corrected, inspected by the PA/E and Owner, and found to be functioning properly, the item shall be removed from the "punchlist" as satisfied.

E. The guarantees, warranties, and obligations of this Contractor for this work under this Contract shall not be extended to include the existing fire alarm, security alarm, other alarm systems, intercom, lighting, energy management and electrical systems beyond the date of final acceptance of the work under this Contract.

1.30 PAINTING

A. Provide painting and touch-up painting of all exposed piping, ductwork, support structures, etc., and all unfinished equipment (concealed or exposed). Refer to Section 15190 for color scheme requirements of pipes and identification markers.

B. Deliver materials to job site in new, original, and unopened containers bearing manufacturer's name, trade name, and label analysis. Store where indicated in accordance with manufacturer's instructions.

C. Do not apply paint in snow, rain, fog or mist or when relative humidity exceeds 85%. Do not apply paint to damp or wet surfaces.

D. Protect work of other trades. Correct any painting related damages by cleaning, repairing, or replacing, and refinishing, as directed by Engineer.

E. Provide finish coats which are compatible with prime paints used. Provide barrier coats over incompatible primers where required. Notify Engineer in writing of anticipated problems using specified coatings with substrate primed by others.

F. Perform preparation and cleaning procedures in strict accordance with coating manufacturer's instructions for each substrate condition.

G. Remove hardware and accessories, machined surfaces, plates, lighting fixtures and similar items in place and not to be finish-painted or provide surface-applied protection. Re-install removed items and remove protective coverings at completion of work.

H. Prepare cementitious surfaces of concrete, concrete block, and similar materials to be painted by removing efflorescence, chalk, dust, dirt, grease and oils, and by roughing to remove glaze. Determine alkalinity and moisture content of surfaces to be painted before beginning painting. Do not paint over surfaces where alkalinity or moisture content exceeds manufacturer's recommendations.

I. Clean ferrous surfaces which are not galvanized or shop-coated. Remove oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning. Touch-up shop-applied prime coats wherever damaged. Clean galvanized surfaces free of oil and surface contaminants with non-petroleum based solvent. Completely paint all welds prior to application of insulation or other protective covering. Non-insulated piping shall be painted entirely.

J. Mix, prepare, and store painting and finishing materials in accordance with manufacturer's directions. Use applicators, and techniques best suited for materials and surfaces to which applied.

K. Application

1. Apply painting and finishing materials in accordance with manufacturer's directions. Use applicators, and techniques best suited for materials and surfaces to which applied.

2. Apply additional coats when undercoats, stains or other conditions show through final paint coat, until paint film is of uniform finish, color, and appearance.

3. Paint interior surfaces of ducts, where visible through registers or grilles, flat, non-specular black.

4. Paint back sides of access panels, and removable or hinges covers to match exposed surfaces. Finish exterior doors on tops, bottoms, and edges same as exterior faces, unless otherwise indicated.

5. Sand lightly between succeeding enamel or varnish coats.

6. Apply prime coat to material which is required to be painted or finished, and which has not been prime coated by others.

7. Apply each material at not less than the manufacturer's recommended spreading rate, to provide a total dry film to thickness of not less than 4.0 mils for an entire coating system of prime and finish coats for 3-coat work.

8. Provide a total dry film thickness of not less than 2.5 mils for entire coating system of prime and finish coat for 2-coat work.

9. Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

L. Exterior Paint Schedule

1. *Concrete, Stucco, and Masonry*: (other than concrete masonry units.)

Lusterless (flat) Acrylic Finish: 2 coats with total dry film thickness not less than 1.5 mils.

***First and Second Coats*: Acrylic Emulsion (FS TT-P-19)**

- ☑ Scott.....420 100% Acrylic Supercoat.
- ☑ Devoe .....15XX Wonder-Shield Exterior Acrylic Latex Flat House Paint
- ☑ Glidden .....Y3525 Spread Glide-on
- ☑ Moore.....Moorglo House and Trim Paint
- ☑ Pittsburgh....6-610 Speedhide Acrylic Latex House Paint
- ☑ P & L .....Pro-Hide Plus Latex House Paint
- ☑ S-W .....Weather Perfect Acrylic Latex Flat Exterior Finish

2. *Concrete Masonry Units*:

Lusterless (flat) Acrylic Finish: 2 coats over filler coat with total dry film thickness not less than 2.5 mils, excluding filler coat.

***Filler Coat*: Solvent Thinned Block Filler for Porous Surfaces (FS TT-F-1098)**

- ☑ Scott.....130 Scot-Kote Acri-Vinyl Latex Block-fil
- ☑ Devoe .....52901 Bloxfil Interior/Exterior Acrylic Latex Block Filler
- ☑ Glidden .....Y-5317 Ultra-Hide Acrylic Latex Block Filler
- ☑ Moore.....Moore's Waterproofing Masonry Paint
- ☑ S-W .....Pro-Mar Block Filler

***First and Second Finish Coats*: Acrylic Emulsion (FS TT-P-19).**

- ☑ Scott.....420 100% Acrylic Supercoat
- ☑ Devoe .....15XX Wonder Shield Exterior Acrylic Latex Flat House Paint
- ☑ Glidden .....Y3515 Spread Glide-on
- ☑ Moore.....Moorgard Latex House Paint
- ☑ S-W .....Weather Perfect Acrylic Latex Flat Exterior Finish

3. *Zinc-Coated Metal*:

High Gloss Alkyd Enamel: 2 Finish coats over primer

***Prime Coat*: Zinc Dust-Zinc Oxide Primer (FS TT-P-641)**

- ☑ Scott.....914 Industrial Finish Zinc Chromate Primer
- ☑ Devoe .....14100 Zinc Dust Primer and Finish
- ☑ Glidden .....Y-5229 Glid-Guard All-Purpose Metal Primer
- ☑ Pittsburgh....6-125 Speedhide Galvanized Steel Primer
- ☑ S-W.....S-W Galvanized Iron Primer

4. *Aluminum*:

High Gloss Alkyd Enamel: 2 Finish coats over primer

***Prime Coat*: Zinc Chromate Primer (FS TT-P-645)**

- ☑ Scott.....914 Industrial Finish Zinc Chromate Primer
- ☑ Devoe .....13201 Mirrolac Galvanized Metal Primer
- ☑ Glidden .....Y-5229 Glid-Guard All-Purpose Metal Primer
- ☑ Moore.....Iron-Clad Zinc Chromate Primer
- ☑ Pittsburgh....6-204 PPG Zinc Chromate Primer
- ☑ P & L .....Noxide Zinc Chromate Primer
- ☑ S-W.....S-W Zinc Chromate Primer

***First and Second Finish Coats*: High Gloss Alkyd Enamel (FS TT-E-489, Class A)**

- ☑ Scott.....550 Polythane Alkyd Polyurethan Gloss Enamel
- ☑ Devoe .....70XX Mirrolac Interior/Exterior Alkyd Gloss Enamel
- ☑ Glidden .....Y-4500-Line - Glid-Guard Alkyd Industrial Enamel
- ☑ Moore.....Moore's Impervo High-Gloss Enamel Interior/Exterior
- ☑ Pittsburgh....6-252 PPG Alkyd Gloss Enamel
- ☑ P & L .....Effecto Enamel
- ☑ S-W.....S-W Metalistic II Enamel

M. Interior Paint Schedule

1. *Concrete and Masonry*: (other than concrete masonry units)

Semi-Gloss Enamel Finish: 2 Coats with total dry film thickness not less than 3.5 mils.

***First Coat*: Interior Flat Latex Base Paint (FS TT-P-29)**

- ☑ Scott.....120 Scot-Kote Acri-Vinyl Latex Primer
- ☑ Devoe .....33XX Wonder-Tones Latex Flat Wall Paint
- ☑ Glidden .....Y-5019 Ultra-Hide PVA Primer Seal
- ☑ Moore.....Moore's Latex Quick-dry Prime Seal
- ☑ Pittsburgh....6-70 Speedhide Latex Flat Wall Paint
- ☑ P & L .....Pro-Hide Plus Latex Flat
- ☑ S-W .....S-W Wall and Wood Primer

***Second Coat*: High Gloss Alkyd Enamel (FS TT-E-489, Class A)**

- ☑ Scott.....500 Scot-Kote Alkyd Enamel Undercoater
- ☑ Devoe .....8801 Velour Alkyd Enamel Undercoat
- ☑ Moore.....Moore's Alkyd Enamel Underbody
- ☑ Pittsburgh....6-6 Speedhide Quick-Drying Enamel Undercoater
- ☑ P & L .....Pro-Hide Plus Latex Flat
- ☑ S-W .....S-W Wall and Wood Primer

***Third Coat*: Odorless Interior Semi-Gloss Alkyd Enamel (FS TT-E-509)**

- ☑ Scott.....540 Scot-Glo Alkyd Polyurethane Semi-Gloss Enamel
- ☑ Devoe .....26XX Velour Alkyd Semi-Gloss Enamel
- ☑ Glidden .....Y-4600 Line Spread Luster Semi-Gloss Enamel
- ☑ Moore.....Moore's Satin Impervo Enamel
- ☑ Pittsburgh....17-109 Wall-Hide Semi-Gloss Enamel
- ☑ P & L .....Pro-Hide Plus Alkyd Semi-Gloss
- ☑ S-W .....S-W Pro-Mar Alkyd Semi-Gloss Enamel

2. *Concrete Masonry Units*:

Semi-Gloss Alkyd Enamel Finish: 2 Coats over filled surface with total dry film thickness not less than 3.5 mils, excluding filler coat.

***Filler Coat*: Solvent-Thinned Block Filler (FS TT-P-1098). Apply filler coat at a rate to ensure complete coverage with pores filled.**

- ☑ Scott.....130 Scot-Kote Acri-Vinyl Latex Primer
- ☑ Devoe .....52901 Bloxfil Acrylic Flat Latex Block Filler
- ☑ Glidden .....Y-5317 Line Ultra-Hide Acrylic Block Filler
- ☑ Moore.....Moore's Waterproofing Masonry Paint
- ☑ S-W.....S-W Pro-Mar Block Filler

***First Coat*: Enamel Undercoater (FS TT-E-543)**

- ☑ Scott.....500 Scot-Kote Alkyd Enamel Undercoater
- ☑ Devoe .....8801 Velour Alkyd Enamel Undercoat
- ☑ Glidden .....Y-5019 - PVA Primer
- ☑ Moore.....Moore's Alkyd Enamel Underbody
- ☑ S-W.....S-W Pro-Mar Alkyd Semi-Gloss Enamel

***Second Coat*: Odorless Interior Alkyd Semi-Gloss Enamel (FS TT-E-509)**

- ☑ Scott.....540 Scot-Kote Alkyd Polyurethane Semi-Gloss Enamel
- ☑ Devoe .....26XX Velour Alkyd Semi-Gloss Enamel
- ☑ Moore.....Moore's Satin Impervo Enamel
- ☑ S-W.....S-W Pro-Mar Alkyd Semi-Gloss Enamel

3. *Gypsum Drywall Systems*:

Odorless Semi-Gloss Alkyd Enamel Finish: 3 coats with total dry film thickness not less than 2.5 mils.

***First Coat*: Interior Latex Base Primer Coat (FS TT-P-650)**

- ☑ Scott.....120 Scot-Kote Acri-Vinyl Latex Primer
- ☑ Devoe .....50801 Wonder-tones Latex Primer and Sealer
- ☑ Glidden .....Y-3416 - Spread Primer Sealer
- ☑ Moore.....Moore's Latex Quick-Drying Interior Latex Primer Sealer
- ☑ S-W.....S-W Pro-Mar Latex Wall Primer

***Second and Third Coats*: Odorless Interior Semi-Gloss Alkyd Enamel (FS TT-E-509)**

- ☑ Scott.....540 Scot-Glo Alkyd Polyurethane Semi-Gloss Enamel
- ☑ Devoe .....26XX Velour Alkyd Semi-Gloss Enamel
- ☑ Glidden .....Y-4600-Line - Sped Luster Semi-Gloss
- ☑ Moore.....Moore's Satin Impervo Enamel
- ☑ Pittsburgh....27-109 Wall-Hide Semi-Gloss Enamel
- ☑ P & L .....Pro-Hide Plus Alkyd Semi-Gloss
- ☑ S-W .....S-W Pro-Mar Alkyd Semi-Gloss Enamel

4. *Plaster*:

Lusterless (Flat) Acrylic Finish: 2 Coats

***First and Second Coats*: Acrylic Emulsion (FS TT-P-19)**

- ☑ Scott.....410 100% Acrylic Supercoat Flat
- ☑ Devoe .....15XX Wonder-Shield Acrylic Latex Flat House Paint
- ☑ Glidden .....Y-3525 - Line Spread Glide-on
- ☑ Pittsburgh....6-610 Speedhide Acrylic Latex House Paint
- ☑ P & L .....Pro-Hide Plus Latex House Paint
- ☑ S-W .....S-W Wall and Wood Primer

5. *Ferrous Metal*:

Semi-Gloss Enamel Finish: 2 coats over primer, with total dry film thickness not less than 2.5 mils.

***Prime Coat*: Red Lead Base Primer (FS TT-P-86). Prime coat is not required on items delivered shop primed.**

- ☑ Scott.....914 Industrial Finish Zinc Chromate Primer
- ☑ Devoe .....41821 Bar-ox Red Metal Primer
- ☑ Glidden .....Y-5532 - Glid-Guard Red Lead Metal Primer
- ☑ Moore.....Iron-Clad Retardo Rust Inhibitive Paint
- ☑ Pittsburgh....6-6 Speedhide Quick-Drying Enamel Undercoater
- ☑ P & L .....Interior Trim Primer

***First Coat*: Interior Enamel Undercoat (FS TT-E-543)**

- ☑ Scott.....540 Scot-Glo Alkyd Polyurethane Semi-Gloss Enamel.
- ☑ Devoe .....8801 Velour Alkyd Enamel Undercoat
- ☑ Glidden .....Y-4600 Series Spread Luster Semi-Gloss Enamel
- ☑ Moore.....Moore's Alkyd Enamel Underbody
- ☑ Pittsburgh....6-6 Speedhide Quick-Drying Enamel Undercoater
- ☑ P & L .....Interior Trim Primer
- ☑ S-W.....S-W Pro-Mar Alkyd Semi-gloss

***Second Coat*: Odorless Interior Semi-Gloss Alkyd Enamel (FS TT-E-509)**

- ☑ Scott.....540 Scot-Glo Alkyd Polyurethane Semi-Gloss Enamel
- ☑ Devoe .....26XX Velour Alkyd Semi-Gloss Enamel
- ☑ Glidden .....Y-4600-Line - Sped Luster Semi-Gloss
- ☑ Moore.....Moore's Satin Impervo Enamel
- ☑ Pittsburgh....27-109 Wall-Hide Semi-Gloss Enamel
- ☑ P & L .....Pro-Hide Plus Alkyd Semi-Gloss
- ☑ S-W.....S-W Pro-Mar Alkyd Semi-Gloss Enamel

6. *Zinc-Coated Metal*:

Semi-Gloss Finish: 2 Coats over primer, with total dry film thickness not less than 2.5 mils.

***Prime Coat*: Zinc Dust - Zinc Oxide Primer Coating (FS TT-P-641).**

- ☑ Scott.....914 Industrial Finish Zinc Chromate Primer
- ☑ Devoe .....14100 Zinc Dust Primer and Finish
- ☑ Glidden .....Y-5229 Glid-Guard All-Purpose Metal Primer
- ☑ Moore.....Iron-Clad Galvanized Metal Primer
- ☑ Pittsburgh....6-215/6-216 Speedhide Galvanized Steel Paint Zinc Dust
- ☑ S-W.....S-W Galvanized Iron Primer

***Second Coat*: Interior Enamel Undercoat (FS TT-E-543)**

- ☑ Scott.....500 Scot-Kote Alkyd Enamel Undercoater
- ☑ Devoe .....8801 Velour Alkyd Enamel Undercoat
- ☑ Glidden .....Y-4600 Line Spread Luster Semi-Gloss Enamel
- ☑ Moore.....Moore's Alkyd Enamel Underbody
- ☑ Pittsburgh....6-6 Speedhide Quick-Drying Enamel Undercoater
- ☑ S-W.....S-W Pro-Mar Alkyd Semi-Gloss Enamel

***Third Coat*: Odorless Interior Alkyd Semi-Gloss Enamel (FS TT-P-509)**

- ☑ Scott.....540 Scot-Glo Alkyd Polyurethane Semi-Gloss Enamel
- ☑ Devoe .....26XX Velour Alkyd Semi-Gloss Enamel
- ☑ Glidden .....Y-4600 Line Spread Luster Semi-Gloss Enamel
- ☑ Moore.....Moore's Satin Impervo Enamel
- ☑ Pittsburgh....17-109 Wall-Hide Semi-Gloss Enamel
- ☑ S-W.....S-W Pro-Mar Alkyd Semi-Gloss Enamel

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SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION

NOT APPLICABLE

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SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron, single-flange butterfly valves.
3. High-performance butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron, center-guided swing check valves.
8. Iron, plate-type check valves.
9. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.

4. Set butterfly valves closed or slightly open.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.

2. Handlever: For quarter-turn valves.

3. Handwheel: For valves other than quarter-turn types.

4. Handlever: For quarter-turn valves NPS 6 and smaller.

5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2.5-inch stem extensions and the following features:

1. Butterfly Valves: With extended neck.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

a. Conbraco Industries, Inc.; Apollo Valves.

b. Hammond Valve.

c. Milwaukee Valve Company.

d. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Three piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

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

a. Crane Co.; Crane Valve Group; Jenkins Valves.

b. Crane Co.; Crane Valve Group; Stockham Division.

c. Milwaukee Valve Company.

d. NIBCO INC.

e. Tyco Valves & Controls; a unit of Tyco Flow Control.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating: 150 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM.

f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

2.4 HIGH PERFORMANCE BUTTERFLY VALVES—BELOW GROUND SERVICE

A. 10" through 24": 150 psi tight-closing , rubber seated type conforming to the design standards of ANSI/AWWA C504. Valves shall be bubble tight at the rated pressure in either direction and shall be suitable for throttling service and/or operation after long periods of inactivity in buried soil and/or submerged up to 10 feet below water.

B. Manufacturer shall have manufactured this product and have proof of satisfactory installed history for a minimum of five years and show proof of compliance with ANSI/AWWA C504. All valves shall be hydrostatic and leak tested in accordance with ANSI/AWWA C504.

C. Valve body shall be constructed of cast iron ASTM A126, Class B, with ANSI B16.1 drilled flange. Disc shall be concentric design with ductile iron ASTM A536, Grade 65-45-12 with 316 stainless edge. Shaft shall be one piece through shaft of 18-8 stainless steel, corresponding to the requirements of AWWA C504, latest revision, and shall be fastened by a threaded disc pin and provide a positive leak proof connection of the shaft to the disc. Shaft bearings shall be of the self-lubricating, corrosion-resistant, sleeve type and be designed for horizontal and/or vertical shaft load. Packing shall be self adjusting and suitable for vacuum or pressure service.

D. Valve seats shall be located in the body only and shall be of a synthetic rubber compound suitable for the service and shall be designed so that no adjustments or maintenance is required.

E. Valves shall be coated per AWWA C550 and in full compliance with NSF-61.

F. Provide gear operators furnished with AWWA 2 inch nut and sealed housing designed for buried and submerged service for depths up to 10 feet below water for valves over 6 inches. Provide buried extension shaft with AWWA nut, removable cover, and buried shaft cover and 1 inch extension shafts as necessary for the buried/submerged depth (up to 10 feet) of the valve operator. Contractor to cut shaft and provide buried shaft cover as necessary. Provide two t-handle valve wrenches for the project. Refer also to valve box detail on the drawings for further requirements.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

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

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Jenkins Valves.

c. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 200 psig.

c. Body Design: Vertical flow.

d. Body Material: ASTM B 61 or ASTM B 62, bronze.

e. Ends: Threaded.

f. Disc: Bronze.

2.6 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

a. American Valve, Inc.

b. Crane Co.; Crane Valve Group; Crane Valves.

c. Crane Co.; Crane Valve Group; Jenkins Valves.

d. Crane Co.; Crane Valve Group; Stockham Division.

e. Kitz Corporation.

f. Milwaukee Valve Company.

g. NIBCO INC.

h. Red-White Valve Corporation.

i. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.

b. CWP Rating: 300 psig.

c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.

e. Ends: Threaded.

f. Disc: Bronze.

2.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Renewable Metal Seats and Disc:

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

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Jenkins Valves.

c. Crane Co.; Crane Valve Group; Stockham Division.

d. Hammond Valve.

e. Milwaukee Valve Company.

f. NIBCO INC.

g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.

b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.

d. Body Design: Clear or full waterway.

e. Body Material: ASTM A 126, gray iron with bolted bonnet.

f. Ends: Flanged.

g. Trim: Bronze.

h. Gasket: Asbestos free.

2.8 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Globe, Center-Guided Silent Check Valves with Metal Seat:

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

a. Anvil International, Inc.

b. APCO Willamette Valve and Primer Corporation.

c. Crispin Valve.

d. DFT Inc.

e. GA Industries, Inc.

f. Hammond Valve.

g. Milwaukee Valve Company.

h. NIBCO INC.

i. Sure Flow Equipment Inc.

j. Val-Matic Valve & Manufacturing Corp.

2. Description:

a. Standard: MSS SP-125.

b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.

d. Body Material: ASTM A 126, gray iron.

e. Style: Globe, S.S. spring loaded.

f. Ends: Flanged.

g. Seat: Buna-N Bonded to Bronze.

2.9 IRON, PLATE-TYPE CHECK VALVES

A. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:

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

a. APCO Willamette Valve and Primer Corporation.

b. Crane Co.; Crane Valve Group; Crane Valves.

c. Mueller Steam Specialty; a division of SPX Corporation.

d. Val-Matic Valve & Manufacturing Corp.

2. Description:

a. Standard: API 594.

b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.

c. NPS 14 to NPS 24, CWP Rating: 250 psig.

d. Body Design: Wafer, spring-loaded plates.

e. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.

f. Seat: Bronze.

2.10 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.

2. Roto Hammer Industries.

3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.

2. Attachment: For connection to ball and butterfly valve stems.

3. Sprocket Rim with Chain Guides: Aluminum, of type and size required for valve. Include zinc coating.

4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball and butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, or butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service except Steam: ball, or butterfly valves.

4. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

b. NPS 2-1/ and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valve, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

4. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Copper Pipe NPS 2 and Smaller:

1. Ball Valves: Two or Three piece, full port, brass with stainless-steel trim.

2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.

2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.

3. High-Performance Butterfly Valves: Class 150, single flange.

4. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring or iron.

6. Iron, Center-Guided Check Valves: Class 150, globe, metal seat.

7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Copper Pipe NPS 2 and Smaller:

1. Ball Valves: Two or Three piece, full port, brass with stainless-steel trim.

2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.

2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.

3. High-Performance Butterfly Valves: Class 150, single flange.

4. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring or iron.

6. Iron, Center-Guided Check Valves: Class 250, globe, metal seat.

7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.

3.7 HEATING-WATER VALVE SCHEDULE

A. Copper Pipe NPS 2 and Smaller:

1. Ball Valves: Two or Three piece, full port, brass with stainless-steel trim.

2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.

2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.

3. High-Performance Butterfly Valves: Class 150, single flange.

4. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring or iron.

6. Iron, Center-Guided Check Valves: Class 150, globe, metal seat.

7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.

*** END OF SECTION 23 05 23 ***

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
5. Division 23 Section(s) “Ductwork" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.

2. Fiberglass pipe hangers.

3. Thermal-hanger shield inserts.

4. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.

2. Metal framing systems. Include Product Data for components.

3. Fiberglass strut systems. Include Product Data for components.

4. Pipe stands. Include Product Data for components.

5. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code—Steel."

2. AWS D1.2, "Structural Welding Code—Aluminum."

3. AWS D1.3, "Structural Welding Code—Sheet Steel."

4. AWS D1.4, "Structural Welding Code—Reinforcing Steel."

5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. AAA Technology & Specialties Co., Inc.

2. Bergen-Power Pipe Supports.

3. B-Line Systems, Inc.; a division of Cooper Industries.

4. Carpenter & Paterson, Inc.

5. Empire Industries, Inc.

6. ERICO/Michigan Hanger Co.

7. Globe Pipe Hanger Products, Inc.

8. Grinnell Corp.

9. GS Metals Corp.

10. National Pipe Hanger Corporation.

11. PHD Manufacturing, Inc.

12. PHS Industries, Inc.

13. Piping Technology & Products, Inc.

14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.

3. GS Metals Corp.

4. Power-Strut Div.; Tyco International, Ltd.

5. Thomas & Betts Corporation.

6. Tolco Inc.

7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. Hilti, Inc.

b. ITW Ramset/Red Head.

c. Masterset Fastening Systems, Inc.

d. MKT Fastening, LLC.

e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-Type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Empire Industries, Inc.

c. Hilti, Inc.

d. ITW Ramset/Red Head.

e. MKT Fastening, LLC.

f. Powers Fasteners.

2.6 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

C. Low-Type , Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Available Manufacturers:

a. MIRO Industries.

D. High-Type , Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

c. Portable Pipe Hangers.

2. Base: Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type , Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Available Manufacturers:

a. Portable Pipe Hangers.

2. Bases: One or more plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

B. Sleeves for Pipes through Non-fire Walls or Footings. Form with steel pipe or 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

C. Sleeves through outside walls shall be made with 18 gauge galvanized steel and fitted with chrome escutcheon covers at all finished surfaces.

D. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL Listed. Contractor shall submit manufacturer's UL approved methods for firesafing all types required for the project as coordinated with the methods of floor and wall construction. Refer to the plans for further requirements.

E. Sleeves for Round Ductwork: Form with galvanized steel.

F. Sleeves for Rectangular Ductwork: Form with galvanized steel.

G. Caulk: Silicone sealant of top quality

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

C. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degF pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-Type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 degF piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degF piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

    b. Medium (MSS Type 32): 1500 lb.

    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

   a. Horizontal (MSS Type 54): Mounted horizontally.

   b. Vertical (MSS Type 55): Mounted vertically.

   c. Trapeze (MSS Type 56): Two vertical-Type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS P-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand types except Curb-Mounting Type : Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

   b. NPS 4: 12 inches long and 0.06 inch thick.

   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

Q. Support horizontal piping as follows:

PIPE SIZE (INCHES)	MAXIMUM HANGER SPACING	HANGER ROD DIAMETER
1/2 to 1-1/4	6'-6"	3/8"
1-1/2 to 2	9'-0"	3/8"
2-1/2 to 3	10'-0"	1/2"
4 to 6	10'-0"	3/4"
8 to 12	14'-0"	7/8"
14 to 18	20'-0"	1"
PVC (All Sizes)	4'-0"	3/8"

R. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

S. Place a hanger within 12 inches of each horizontal elbow.

T. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

U. Support vertical piping at every floor and support from wall midway between ceiling and floor or at 12 feet maximum spacing, whichever is less. Support vertical cast iron pipe at each floor and at each hub.

V. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

W. Support riser piping independently of connected horizontal piping.

X. All auxiliary steel required for pipe supports shall be furnished and installed by this Contractor. Where building structure is not usable for pipe supports, provide steel members, channels, angles, or "UNISTRUT" components for piping support. All auxiliary steel exposed to weather shall be galvanized.

Y. Provide all steel required for support of pipes other than steel shown on structural Engineer's drawings.

Z. Interior Pipe Guides, Expansion Loops, and Anchors: Provide pipe guides, expansion loops, and anchors on hot water heating pipes installed above the ceiling. Expansion loops shall be installed every 50 feet and supported from building structure with pipe guides on 10 feet spacing. Piping shall be anchored to the structure as necessary for directional expansion control.

AA. Located In or Around Cooling Tower Yards: Pipe hangers, equipment supports, miscellaneous structure components, hardware, bolts, washers, nuts, screws, etc., shall be non-metallic polyester resin, vinyl ester resin, fiberglass, glass reinforced polyurethane or 316 stainless steel.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Brace and fasten with flanges bolted to structure.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide equipment bases and supports of concrete Type under all mechanical equipment and as shown on drawings.

D. Provide lateral bracing, to prevent swaying, for equipment supports. Provide rigid anchors for pipes after vibration isolation components are installed.

E. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.7 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash and seal.

C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with Manufacturer's instructions for sound control.

3.8 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Extend sleeves through floors one inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

D. Install chrome plated steel escutcheons at finished surfaces.

E. Sleeves installed in exterior walls with exposed ends shall be non-corrosive type sleeves (i.e., stainless steel).

*** END OF SECTION 23 05 29 ***

SECTION 23 05 48

VIBRATION AND WIND RESTRAINT CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Elastomeric hangers.
3. Spring hangers.
4. Pipe riser resilient supports.
5. Resilient pipe guides.
6. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 130 mph unless otherwise referenced on structural drawings.
2. Building Classification Category: Refer to Structural Drawings.
3. Refer to structural drawings for minimum load requirements.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Delegated-Design Submittal: Equipment mounted outdoors shall comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation wind forces required to select wind restraints.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

2. Riser Supports for Building Hot Water Heating Piping: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. HVAC Pumps Located on floor level other than grade level: Provide Vibration Isolation Base Details with detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Wind-Restraint Details:

a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.

c. Coordinate wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.

2. Isolation Technology, Inc.

3. Kinetics Noise Control.

4. Mason Industries.

5. Vibration Eliminator Co., Inc.

6. AVNEC Incorporated.

7. Kevflex.

B. Isolation Pads—A double deflection pad-type mounting consisting of two layers of 3/8" thick ribbed or waffled Neoprene pads bonded to a 16 gage galvanized steel separator plate. Pads shall be sized for approximately 20 to 40 psi load and a deflection of 0.12" to 0.16".

C. Elastomeric Hangers Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

D. Spring Hangers Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

E. Flanged Pump Piping Isolator, spherical rubber expansion joint constructed of molded neoprene, nylon cord reinforced, with integral steel floating flanges, suitable for pressure up to 225# (4 to 1 safety factor) and temperatures up to 225°F. Connectors shall have minimum movement capability of 1/2" compression, 3/8" extension 1/2" lateral and 15° angular. Where allowable movements will be exceeded or where operating pressures exceed the following, control rods shall be installed at each connector to limit elongation to 3/8".

through 4"..... 200 psi
5" to 10"..... 150 psi
12" to 14"..... 100 psi
16" to 24"..... 50 psi

Control units shall be of the spring isolated design through 8" and neoprene isolated for 10" and larger to limit noise and vibration transmission through the control rods.

F. Pipe Riser Resilient Support All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

G. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc.

B. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

b. Provide Spring Isolators on Piping Connected to Isolated Equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and wind-control devices to indicate capacity range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

3.3 VIBRATION-CONTROL AND WIND-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install wind restraints on outdoor HVAC equipment.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install wind-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 HVAC VIBRATION-CONTROL DEVICE SCHEDULE

A. Supported or Suspended Equipment: Install vibration isolators and flexible connectors for the following motor driven equipment.

1. Pumps: Flanged Pump Piping Isolator (mount on suction and discharge side of pump piping).

2. Chillers, Cooling Towers, Condensing Units, and Chilled Water Air Handling Units: Neoprene Isolation Pads.

3. Suspended Split System Air Handling Units and Power Ventilators: Elastomeric or Spring Hangers.

*** END OF SECTION 23 05 48 ***

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.

3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive. Colors shall comply with ANSI A13.1. Size markers and letters as follows:

OUTSIDE DIAMETER OF INSULATION OR PIPE	LENGTH OF COLOR FIELD	SIZE OF LETTERS
¾" - 2"	1" x 8"	¾"
2½" - 6"	2¼" x 13"	1¾"
8" - 10"	4" x 24"	2½"
Over 10"	4" x 32"	3½"
Ductwork and Equipment	All	3½"

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

A. Valve Tags: 1-1/2 inch diameter, stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.

2. Fasteners: Reinforced grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic equipment markers. Small devices, such as in-line pumps, may be identified with metal tags.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 20 feet along each run including risers and drops, adjacent to each valve and “T”, at each side of penetration of structure or enclosure, and at each obstruction.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

8. Tags may be used on small diameter piping.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue : For cold-air supply ducts.

2. Yellow : For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels at air handlers, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Identify as to air handling unit number and service (supply air , return air, exhaust, outside air, etc.).

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Provide a valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 EQUIPMENT LOCATOR TACK

A. Equipment Located Above Ceiling (i.e., VAV boxes, fans, air handlers, fire dampers, smoke dampers, etc.): Provide equipment locator tack, located on the ceiling directly below the equipment, to be spot marked and so mark is easily visible from the floor. Use a permanent marker and label each tag with the name of the equipment. Color code equipment by type as follows:

EQUIPMENT ABOVE CEILING	COLOR
Air Handlers/Fan Coil Units	Light Blue
Exhaust Fans	Green
VAV Boxes	Yellow
Duct Heaters	Orange
Fire Dampers	Red
Smoke Dampers	Red

B. Ductwork Volume Dampers Above the Ceiling: Tie an orange tape flag, minimum 18” long, from each volume damper. Let tape hang down vertically.

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

b. Dual-duct systems.

c. Variable-air-volume systems.

d. Multizone systems.

e. Induction-unit systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.

b. Variable-flow hydronic systems.

c. Primary-secondary hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. LEED Submittal:

1. Air-Balance Report for LEEDPrerequisiteEQ1: Documentation of work performed for ASHRAE62.1, Section7.2.2, "Air Balancing."

B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part3.

D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

E. Certified TAB reports.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

H. The test and balance firm will submit two (2) copies of data for the testing and balancing for the approval of the Project Architect/Engineer and three (3) file copies to the Owner and two (2) copies to this Contractor.

I. All data and information shall be compiled in a neat, orderly format on 8-1/2" x 11" test forms and shall be signed and sealed by the certified individual as previously described.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Meet with Contractor on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.

b. The TAB plan.

c. Coordination and cooperation of trades and subcontractors.

d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Owner. Written report submitted to the Engineer a minimum of 15 days prior to Substantial Completion of each project phase. The Owner will then perform a verification TAB. If discrepancies are found, they will be corrected by this Contractor and the contractor will responsible to pay for additional trips for the Owner’s TAB representatives to verify.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE111, Section5, "Instrumentation." All instruments used shall be accurately calibrated within six months of testing and balancing and shall be maintained in good working order.

F. The final result of balancing shall be to provide uniform air temperatures within a two (2) degree F spread in the conditioned space at peak load conditions.

G. In the event of dispute, the Owner or Contractor or Project Architect/Engineer may choose to provide verification of test and balance reports, and such verification shall be by a second independent agency selected by the Engineer. Reports found to be inaccurate will be disallowed, and the Contractor's test and balance firm will be required to repeat operations under the supervision of the second independent agency until accurate reports are completed and agreed upon, provided the Contractor's TAB firm is found to be at fault in the judgment of the Engineer. The cost of disputed test and balance work shall be borne by the Owner or Contractor (whichever is found to be at fault).

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 SCOPE

A. Description

1. The Contractor shall, at the Contractor's expense, procure the services of an independent testing and balance firm which specializes in the balancing and testing of heating, ventilating and air conditioning systems. This specialty services firm shall balance, adjust and test water circulation, air moving equipment, air distribution and/or exhaust systems as herein specified.

2. Test and balance work shall not begin until all systems have been completed and are in full working order to the satisfaction of the Project Architect/Engineer and the Owner. This Contractor shall make all preliminary tests and adjustments before advising in writing that test and balance work is ready to begin and shall place all systems and equipment into full operation during each working day of testing and balancing.

B. Replacement pulleys (adjustable and non-adjustable), additional balancing dampers, pressure taps, balancing valves, cocks and fittings, etc., required to effect proper air and water balance shall be furnished and installed by this Contractor at no additional cost to the Owner. This Contractor shall do this work as soon as possible so as not to delay the completion of the test and balance work.

C. Air filters shall be replaced and strainers shall be cleaned by this Contractor before proceeding with test and balance and thereafter as required by the test and balance firm.

D. Systems shall be placed into service using approved start up procedures. This (mechanical) contractor shall be responsible for proper initial setting and adjustment of HVAC equipment, air handlers, VAV boxes, exhaust fans, etc. furnished and installed by him.

E. This Contractor shall provide test openings as required; shall operate HVAC equipment and provide trades persons to assist and make adjustments for test and balance during the process.

F. When the Owner's verification test and balance firm is ready to test according to the established schedule, but is prevented from testing and balancing, making adjustments or taking measurements due to incompleteness of the work, all extra charges for test and balance attributable to the delay may be back charged to this Contractor. The Project Architect/Engineer shall be the judge as to whether a delay has occurred and back charges due the Owner, and which, if judged proper, shall be effected through a Change Order reducing the Contract Sum.

G. The Contractor's test and balance firm shall periodically visit the site during construction of the HVAC system. No less than two visits per phase will be made. Should methods, materials or workmanship being used adversely affect balancing and adjusting work, the test and balance agency shall report its findings in writing to the Contractor with recommendations for correction.

H. The Contractor's test and balance firm has agreed or shall agree to carry out the test and balance in accordance with the AABC National Standards for Total Systems Balance or the NEBB Procedural Standards for Testing, Adjusting and Balancing or Environmental Systems, Fourth edition, and in conformance with ASHRAE Handbook, Chapter 34, Testing, Adjusting and Balancing and as outlined in this Specification Section.

I. This Contractor shall furnish to the testing and balancing agency a complete set of plans and specifications, addenda, shop drawings, schedules and change orders as may be required.

PART 2 PRODUCTS

(NOT APPLICABLE)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Ductwork" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.

3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE62.1, Section7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Ductwork."

3.5 BUILDING PRESSURIZATION TESTING AND BALANCING

A. This Contractor shall measure the building static pressure relative to the outdoor static pressure (differential pressure measurement) and balance each air delivery system (system) to obtain 0.03 inches of water column positive pressure within that portion of the building with all exterior openings (doors and windows) closed.

B. This Contractor shall make preliminary field differential pressure measurements of the building upon completion of the initial testing and balancing of the entire building or buildings HVAC systems. This shall be accomplished once the air delivery systems have been fully tested and balanced to within 10 percent of the scheduled air flow rates per the Contract Documents. A preliminary test and balance report (hand written copies are satisfactory) shall be submitted to the Engineer of Record at this point in the project. Based upon the initial building differential pressure measurements, the Contractor shall proceed with the Building Pressurization Testing and Balancing final field adjustments. If there are any questions regarding the building pressurization testing and balancing requirements, the Contractor should contact the Engineer and clarify the intended process prior to making the final field adjustments.

C. This Contractor shall review the drawings and ventilation schedule for each system to determine whether the system ventilation outside air flow rate is determined by the number of occupants “people” or determined by the minimum exhaust “exhaust” requirements. If the ventilation outside air is determined by “people”, this contractor shall adjust the building pressure by readjusting the relief fan volumetric flow rate for that system as directed by the Engineer. If the ventilation outside air is determined by “exhaust”, the building pressure shall be revised by adjusting the volumetric flow rate of outside air for that system as directed by the Engineer. Where the system design employs the use of barometric dampers in addition to or in lieu of relief fans for building pressurization control, the Contractor shall also adjust the barometric damper to obtain the stated building pressure.

D. In either building pressurization balancing adjustment scenario, the ventilation rate shall not be reduced below the minimum required ventilation flow rate as determined by AHRAE 62.1 and represented on the Ventilation Schedule.

E. This Contractor shall document the final building pressurization measurements as a basic part of the test and balance report. The building pressurization measurement data and balancing methodology shall be presented in the report for each system. This shall include a narrative describing the method that was used to adjust each system, and the location of each reported differential pressure measurement.

3.6 SOUND TESTING

A. Using approved instruments, the test and balance firm shall conduct tests in selected areas of the building as specified below. Sound level readings shall be measured in decibels on the "A" and "C" scales of the General Radio Company sound level meter, or equal sound level meter that meets the current American Standards (224.3-1944) based on the acoustic reference power of D.B./RE 10.13 watts. Readings shall set forth the total random sound level of the selected rooms or areas with the system in operation, as compared to total background sound level with the system not in operation. The system increase over the background level shall be recorded in decibels on the "A" and "C" scales. If sound levels are above those listed below, adjustments shall be made by this Contractor to bring the sound level within the range set forth. If this cannot be done with the equipment as installed, recommendations shall be made by the test and balance firm to correct the sound level to within the specified range. Additions of sound traps, insulation, or dampers shall be made by this Contractor under the direction of the balance agency at no additional cost to the Owner, provided the noise is due to Contractor's fault. Sound level readings (in decibels) shall be taken at each diffuser, grille or register in occupied areas. The sound levels shall be approximately 45 degrees to the center of the diffuser, etc., on the "A" and "C" scales of a General Radio Company sound level meter. The computed equivalent sound level meter readings weighting scale "A" (DBA) shall not exceed 40 for general office type space, 35 for classroom and conference room type space and 30 for sensitive areas such as libraries or auditoriums.

B. Sound measurements shall be taken in the following locations:

1. A typical classroom remote from mechanical equipment rooms.

2. A typical classroom adjacent to mechanical equipment room.

3. Typical offices.

4. Special assembly rooms such as auditoriums, music rooms, libraries.

C. When a typical space (1, 2, or 3 above) has been tested and passed, all such spaces shall be considered complying. Conversely, if a typical space fails, all such spaces shall be considered as failed and require testing.

D. Unless test results indicate failure to comply with the intention of these Specifications, sound testing shall be done only once, preferably during cooling season.

E. Sound levels at maximum rates shall be listed on the TAB report on a point measured basis as required above.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Owner and Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.8 PROCEDURES FOR DUAL-DUCT SYSTEMS

A. Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.

B. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.

1. If insufficient static pressure exists, increase airflow at the fan.

C. Test and adjust the constant-volume mixing boxes as follows:

1. Verify both hot and cold operations by adjusting the thermostat and observing changes in air temperature and volume.

2. Verify sufficient inlet static pressure before making volume adjustments.

3. Adjust mixing boxes to indicated airflows within specified tolerances. Measure airflow by Pitot-tube traverse readings or by measuring static pressure at mixing-box taps if provided by mixing-box manufacturer.

D. Do not overpressurize ducts.

E. Remeasure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.

F. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume, dual-duct systems; adjust maximum- and minimum-airflow setting of each mixing box.

3.9 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

3.10 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at maximum airflow through the cooling coil.

B. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

3.11 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow. Close all bypass valves. Set modulating valve to full coil flow.

2. Check liquid level in expansion tank.

3. Check makeup water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation, and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

9. Check all strainers and, if required, clean same.

10. Examine water in system and determine if water has been treated and cleaned. If water appears dirty, test and balance work shall stop and this Contractor shall reclean system as specified in the Project Specifications.

11. Check all air vents at high points of water system and determine if all are installed and operating freely. Make sure all air is removed from the system.

12. Set all temperature controls so all coils are calling for full cooling, and determine that this closes all automatic by-pass valves at coils.

13. Check operation of automatic by-pass valves.

14. Check and set operating temperatures of chillers and heat exchangers to design requirements.

15. Complete air balance work must have been accomplished and all work adjusted and corrected before actual water balance is complete.

3.12 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, turn these dimensions, along with the installed pump curves with the new pump and system curves, for review by the Engineer. Upon approval by the Engineer, the impeller dimensions shall be turned over to the installing contractor for impeller shaving.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.13 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.14 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.15 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check settings and operation of safety and relief valves. Record settings.

3.16 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.17 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.

2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.

3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.

4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.

5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.

6. Capacity: Calculate in tons of cooling.

7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.18 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.

2. Measure entering- and leaving-water temperatures.

3. Measure wet- and dry-bulb temperatures of entering air.

4. Measure wet- and dry-bulb temperatures of leaving air.

5. Measure condenser-water flow rate recirculating through the cooling tower.

6. Measure cooling-tower spray pump discharge pressure.

7. Adjust water level and feed rate of makeup water system.

8. Measure flow through bypass.

3.19 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.20 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.21 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.

2. Water flow rate.

3. Water pressure drop.

4. Dry-bulb temperature of entering and leaving air.

5. Wet-bulb temperature of entering and leaving air for cooling coils.

6. Airflow.

7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.

2. Airflow.

3. Entering- and leaving-air temperature at full load.

4. Voltage and amperage input of each phase at full load and at each incremental stage.

5. Calculated kilowatt at full load.

6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.

2. Airflow.

3. Air pressure drop.

4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.

2. Wet-bulb temperature of entering and leaving air.

3. Airflow.

4. Air pressure drop.

5. Refrigerant suction pressure and temperature.

3.22 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.

2. Measure motor voltage and amperage. Compare the values to motor nameplate information.

3. Check the refrigerant charge.

4. Check the condition of filters.

5. Check the condition of coils.

6. Check the operation of the drain pan and condensate-drain trap.

7. Check bearings and other lubricated parts for proper lubrication.

8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.

2. Coils are clean and fins combed.

3. Drain pans are clean.

4. Fans are clean.

5. Bearings and other parts are properly lubricated.

6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

3.23 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating-Water Flow Rate: Plus or minus 10 percent.

4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.24 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.25 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.

    b. Conditions of filters.

    c. Cooling coil, wet- and dry-bulb conditions.

    d. Face and bypass damper settings at coils.

    e. Fan drive settings including settings and percentage of maximum pitch diameter.

    f. Settings for supply-air, static-pressure controller.

    g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.

3. Duct, outlet, and inlet sizes.

4. Pipe and valve sizes and locations.

5. Terminal units.

6. Balancing stations.

7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.

    b. Location.

    c. Make and type.

    d. Model number and unit size.

    e. Manufacturer's serial number.

    f. Unit arrangement and class.

    g. Discharge arrangement.

    h. Sheave make, size in inches, and bore.

i. Center-to-center dimensions of sheave, and amount of adjustments in inches.

j. Number, make, and size of belts.

k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Filter static-pressure differential in inches wg.

f. Preheat-coil static-pressure differential in inches wg.

g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.

i. Outdoor airflow in cfm.

j. Return airflow in cfm.

k. Outdoor-air damper position.

l. Return-air damper position.

m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.

b. Location.

c. Coil type.

d. Number of rows.

e. Fin spacing in fins per inch o.c.

f. Make and model number.

g. Face area in sq. ft.

h. Tube size in NPS.

i. Tube and fin materials.

j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Average face velocity in fpm.

c. Air pressure drop in inches wg.

d. Outdoor-air, wet- and dry-bulb temperatures in degF.

e. Return-air, wet- and dry-bulb temperatures in degF.

f. Entering-air, wet- and dry-bulb temperatures in degF.

g. Leaving-air, wet- and dry-bulb temperatures in degF.

h. Water flow rate in gpm.

i. Water pressure differential in feet of head or psig.

j. Entering-water temperature in degF.

k. Leaving-water temperature in degF.

l. Refrigerant expansion valve and refrigerant types.

m. Refrigerant suction pressure in psig.

n. Refrigerant suction temperature in degF.

o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Fuel type in input data.

g. Output capacity in Btu/h.

h. Ignition type.

i. Burner-control types.

j. Motor horsepower and rpm.

k. Motor volts, phase, and hertz.

l. Motor full-load amperage and service factor.

m. Sheave make, size in inches, and bore.

n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.

b. Entering-air temperature in degF.

c. Leaving-air temperature in degF.

d. Air temperature differential in degF.

e. Entering-air static pressure in inches wg.

f. Leaving-air static pressure in inches wg.

g. Air static-pressure differential in inches wg.

h. Low-fire fuel input in Btu/h.

i. High-fire fuel input in Btu/h.

j. Manifold pressure in psig.

k. High-temperature-limit setting in degF.

l. Operating set point in Btu/h.

m. Motor voltage at each connection.

n. Motor amperage for each phase.

o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.

b. Location.

c. Coil identification.

d. Capacity in Btu/h.

e. Number of stages.

f. Connected volts, phase, and hertz.

g. Rated amperage.

h. Air flow rate in cfm.

i. Face area in sq. ft.

j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.

b. Air flow rate in cfm.

c. Air velocity in fpm.

d. Entering-air temperature in degF.

e. Leaving-air temperature in degF.

f. Voltage at each connection.

g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.

b. Location and zone.

c. Traverse air temperature in degF.

d. Duct static pressure in inches wg.

e. Duct size in inches.

f. Duct area in sq. ft.

g. Indicated air flow rate in cfm.

h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.

b. Location and zone.

c. Apparatus used for test.

d. Area served.

e. Make.

f. Number from system diagram.

g. Type and model number.

h. Size.

i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Air velocity in fpm.

c. Preliminary air flow rate as needed in cfm.

d. Preliminary velocity as needed in fpm.

e. Final air flow rate in cfm.

f. Final velocity in fpm.

g. Space temperature in degF.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.

b. Location and zone.

c. Room or riser served.

d. Coil make and size.

e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Entering-water temperature in degF.

c. Leaving-water temperature in degF.

d. Water pressure drop in feet of head or psig.

e. Entering-air temperature in degF.

f. Leaving-air temperature in degF.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.

b. Location.

c. Service.

d. Make and size.

e. Model number and serial number.

f. Water flow rate in gpm.

g. Water pressure differential in feet of head or psig.

h. Required net positive suction head in feet of head or psig.

i. Pump rpm.

j. Impeller diameter in inches.

k. Motor make and frame size.

l. Motor horsepower and rpm.

m. Voltage at each connection.

n. Amperage for each phase.

o. Full-load amperage and service factor.

p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.

b. Pump shutoff pressure in feet of head or psig.

c. Actual impeller size in inches.

d. Full-open flow rate in gpm.

e. Full-open pressure in feet of head or psig.

f. Final discharge pressure in feet of head or psig.

g. Final suction pressure in feet of head or psig.

h. Final total pressure in feet of head or psig.

i. Final water flow rate in gpm.

j. Voltage at each connection.

k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.26 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.

b. Measure water flow of at least 5 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

d. Verify that balancing devices are marked with final balance position.

e. Note deviations from the Contract Documents in the final report.

B. Prepare test and inspection reports.

3.27 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

*** END OF SECTION 23 05 93 ***

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Cellular glass.

b. Flexible elastomeric.

c. Mineral fiber.

2. Insulating cements.

3. Adhesives.

4. Mastics.

5. Lagging adhesives.

6. Sealants.

7. Field-applied fabric-reinforcing mesh.

8. Field-applied cloths.

9. Field-applied jackets.

10. Tapes.

11. Securements.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."

2. Division 22 Section "Plumbing Insulation."

3. Division 23 Section "Metal Ducts" for duct liners and dual wall duct requirements.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail insulation application at pipe expansion joints for each type of insulation.

3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

4. Detail removable insulation at piping specialties, equipment connections, and access panels.

5. Detail application of field-applied jackets.

6. Detail application at linkages of control devices.

7. Detail field application for each equipment type.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in piping insulation application with three (3) years minimum experience..

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation prior to operating to operating system. Do not use wet insulation materials or apply insulation to wet surfaces.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cell-U-Foam Corporation; Ultra-CUF.

b. Pittsburgh Corning Corporation; Foamglas Super K.

2. Block Insulation: ASTM C 552, Type I.

3. Special-Shaped Insulation: ASTM C 552, Type III.

4. Board Insulation: ASTM C 552, Type IV.

5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.

7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide the following:

a. Aeroflex USA Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

a. CertainTeed Corp.; Duct Wrap.

b. Johns Manville; Microlite.

c. Knauf Insulation; Duct Wrap.

d. Manson Insulation Inc.; Alley Wrap.

e. Owens Corning; All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide the following:

a. Fibrex Insulations Inc.; Coreplus 1200.

b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000 Pipe Insulation.

d. Manson Insulation Inc.; Alley-K.

e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; FlameChek.

b. Johns Manville; Firetemp Wrap.

c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.

d. Thermal Ceramics; FireMaster Duct Wrap.

e. 3M; Fire Barrier Wrap Products.

f. Unifrax Corporation; FyreWrap.

g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; Triple I.

b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

C. Mineral-fiber, hydraulic-setting cement is suitable for temperatures from 100 to 1200 deg F (38 to 649 deg C) and for a smooth surface.

D. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; SmoothKote.

b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.

c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-96.

b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide the following:

a. Aeroflex USA Inc.; Aeroseal.

b. Armacell LCC; 520 Adhesive.

c. Foster Products Corporation, H. B. Fuller Company; 85-75.

d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide the following:

a. Dow Chemical Company (The); 739, Dow Silicone.

b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

c. P.I.C. Plastics, Inc.; Welding Adhesive.

d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-35.

b. Foster Products Corporation, H. B. Fuller Company; 30-90.

c. ITW TACC, Division of Illinois Tool Works; CB-50.

d. Marathon Industries, Inc.; 590.

e. Mon-Eco Industries, Inc.; 55-40.

f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-10.

b. Foster Products Corporation, H. B. Fuller Company; 35-00.

c. ITW TACC, Division of Illinois Tool Works; CB-05/15.

d. Marathon Industries, Inc.; 550.

e. Mon-Eco Industries, Inc.; 55-50.

f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 200 deg F.

4. Solids Content: 63 percent by volume and 73 percent by weight.

5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-52.

b. Foster Products Corporation, H. B. Fuller Company; 81-42.

c. Marathon Industries, Inc.; 130.

d. Mon-Eco Industries, Inc.; 11-30.

e. Vimasco Corporation; 136.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.

4. Service Temperature Range: Minus 50 to plus 180 deg F.

5. Color: White.

2.7 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; CP-76.

a. Foster Products Corporation, H. B. Fuller Company; 30-45.

b. Marathon Industries, Inc.; 405.

c. Mon-Eco Industries, Inc.; 44-05.

d. Pittsburgh Corning Corporation; Pittseal 444.

e. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Permanently flexible, elastomeric sealant.

5. Service Temperature Range: Minus 100 to plus 300 deg F.

6. Color: White or gray.

7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; CP-76-8.

a. Foster Products Corporation, H. B. Fuller Company; 95-44.

b. Marathon Industries, Inc.; 405.

c. Mon-Eco Industries, Inc.; 44-05.

d. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Fire- and water-resistant, flexible, elastomeric sealant.

5. Service Temperature Range: Minus 40 to plus 250 deg F.

6. Color: Aluminum.

7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 3 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 3 oz./sq. yd. with a thread count of 6 strands by 5.5 meshes per inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.

a. Vimasco Corporation; Elastafab 894.

b. Childers Products, Division of ITW; Chil-Glas No. 10.

c. Pittsburgh Corning, PC Fabric 79.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.

b. P.I.C. Plastics, Inc.; FG Series.

c. Proto PVC Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: Color-code jackets based on system..

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; Metal Jacketing Systems.

b. PABCO Metals Corporation; Surefit.

c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

a. Factory cut and rolled to size.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper thick Polysurlyn.

d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper thick Polysurlyn.

e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

3) Tee covers.

4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

b. Compac Corp.; 110 and 111.

c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.

d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.

3. Thickness: 6.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

b. Compac Corp.; 120.

c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.

d. Venture Tape; 3520 CW.

2. Width: 2 inches.

3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.

c. RPR Products, Inc.; Bands.

2. Aluminum: ASTM B 209 Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. AGM Industries, Inc.; CWP-1.

b. GEMCO; CD.

c. Midwest Fasteners, Inc.; CD.

d. Nelson Stud Welding; TPA, TPC, and TPS.

3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; CWP-1.

2) GEMCO; Cupped Head Weld Pin.

3) Midwest Fasteners, Inc.; Cupped Head.

4) Nelson Stud Welding; CHP.

4. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.

2) GEMCO; Perforated Base.

3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

2) GEMCO; Press and Peel.

3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; RC-150.

2) GEMCO; R-150.

3) Midwest Fasteners, Inc.; WA-150.

4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) GEMCO.

        2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

2. C & F Wire.

3. Childers Products.

4. PABCO Metals Corporation.

5. RPR Products, Inc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 0 and 200 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. Provide self adhesive aluminum tape continuous along staples seams.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. Overlap wrapped insulation 12 inches beyond point of lined duct connections.

Q. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

E. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism. Refer to drawings for details

2. Fabricate boxes from aluminum, at least 0.060 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Ductwork:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Provide vapor barriers. Seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 2 inches o.c. and seal joints with aluminum self adhesive tape.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

   d. Do not overcompress insulation during installation.

   e. Impale insulation over pins and attach speed washers.

   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 60 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.

3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use tape along lap seal to secure joint.

2. Repair holes or tears in jacket by placing tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FIRE-RATED PENETRATIOJNS

A. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.11 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified agency to perform inspections. If there are deviations from the project requirements or questionable installation quality as determined by the inspector or Engineer of Record, the Owner/Engineer may request that sample areas be randomly tested as stated below.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Owner/Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

2. Inspect field-insulated equipment, randomly selected by Owner/Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Owner/Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to combination of three locations of straight pipe or fittings for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply, return and outdoor air.

2. Indoor, exposed supply, return and outdoor air.

3. Indoor, concealed return located in nonconditioned space.

4. Indoor, exposed return located in nonconditioned space.

5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.

6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.

7. Indoor, concealed exhaust.

8. Indoor, exposed exhaust.

B. Items Not Insulated:

1. Fibrous-glass ducts.

2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

3. Factory-insulated flexible ducts.

4. Factory-insulated plenums and casings.

5. Flexible connectors.

6. Vibration-control devices.

7. Factory-insulated access panels and doors.

3.14 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed supply and return air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density (installed R-Value 6.0 minimum).

2. Refer to Division 23 Metal Ducts Section for extent of dual wall factory insulation duct. Overlap dual duct by 12 inches minimum.

B. Concealed exhaust-air duct insulation liner shall be the following:

1. Mineral-Fiber Board: 1 inches thick 3 lb/cu. ft. nominal density.

C. Concealed Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Refer to Division 23 Metal Ducts for factory fabricated ductwork.

D. Exposed ductwork, refer to Division 23 Metal Ducts for factory insulated dual wall - round, flat oval and rectangular duct requirements.

3.15 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with the following:

1. Flexible Elastomeric: 1 inch thick.

D. Heat-exchanger (water-to-water for thermal storage service) insulation shall be the following:

1. Cellular Glass: 3 inches thick.

E. Chilled-water pump insulation shall be the following:

1. Cellular Glass: 2 inches thick.

F. Chilled-water expansion/compression tank insulation shall be the following:

1. Cellular Glass: 2 inches thick.

G. Chilled-water air-separator insulation shall be the following:

1. Cellular Glass: 2 inches thick.

H. Heating-hot-water air-separator insulation shall be the following:

1. Cellular Glass: 2 inches thick.

I. Heat-recovery air-separator insulation shall be the following:

1. Cellular Glass: 2 inches thick.

J. Thermal storage tank insulation (not insulated at the factory) shall be the following:

1. Cellular Glass: 3 inches thick.

K. Deaerator insulation shall be the following:

1. Cellular Glass: 2 inches thick.

L. Piping system chemical shot feeder and side stream filter and interconnecting piping-insulation shall be the following:

1. Flexible Elastomeric: 1 thick.

3.16 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.

2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.17 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F.

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 thick.

B. Chilled Water and Brine, 40 Deg F and below:

1. NPS 2and Smaller: Insulation shall be the following:

a. Cellular Glass: 2-1/2 inches thick.

2. NPS 2-1/2 to NPS 12: Insulation shall be the following:

a. Cellular Glass: 3 inches thick.

3. NPS 14 and Larger: Insulation shall be the following:

a. Cellular Glass: 3 inches thick.

C. Chilled Water and Brine, above 40 Deg F (5 Deg C):

1. NPS 2 and Smaller: Insulation shall be the following:

a. Cellular Glass: 1-1/2 inches thick.

2. NPS 2-1/2 to NPS 12: Insulation shall be the following:

a. Cellular Glass: 2 inches thick.

3. NPS 14 and Larger: Insulation shall be the following:

a. Cellular Glass: 2-1/2 inches thick.

D. Heating-Hot-Water Supply and Return, 200 Deg F and below:

1. NPS 12 and Smaller: Insulation shall be the following:

a. Cellular Glass: 1-1/2 inches thick.

2. NPS 14 and Larger: Insulation shall be the following:

.a Cellular Glass: 2 inches thick.

E. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

F. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

G. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 1-1/2 inches thick.

H. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 1-1/2 inches thick.

I. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 1-1/2 inches thick.

3.18 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation shall be the following:

Cellular Glass: 3 inches thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and below:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

E. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches thick.

3.19 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping and Equipment, Exposed

1. Aluminum, Stucco Embossed: 0.016 thick.

C. Piping and Equipment, Concealed:

1. None.

3.20 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping and Equipment, Exposed:

1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

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SECTION 23 09 00

BUILDING AUTOMATION SYSTEM FOR HVAC (BAS)

PART 1 GENERAL

1.0 SCOPE SUMMARY

A. Provide a Building Automation System (BAS) based on Direct Digital Control (DDC) concepts. This specification is based on a Trane Tracer ES/SC Control System. All field devices and sequence requirements stipulated on the documents shall be a part of this specification.

B. All devices and interconnections necessary to make the BAS fully operable shall be provided by the controls provider whether specifically called for in this specification or not – ancillary devices needed to make the system operational (such as relays; pull boxes; conduits; etc.) shall be provided by the controls provider.

C. Coordinate with the Mechanical systems provider to ensure requirements of the field sensing devices are properly installed per the sensor Manufacturer's published accuracies and turndown ratios.

D. Control system communication buss wiring shall comply with Division 27 (Communication) products and installation requirements. All cables shall be dressed and permanently labeled at each end using approved labels to ensure a neat and organized appearance. Provide CAT rated cables per Division 27 unless otherwise stipulated or approved by the Engineer of Record.

E. Control system field sensor wiring shall be per the sensor Manufacturer's requirements and installed per Division 27 11 00 Structured Cabling techniques. All cables shall be dressed and permanently labeled at each end using approved labels to ensure a neat and organized appearance.

F. Provide a separate **Bid Alternate** to add the entire Palladium Building and associated Central Energy Plant to the College's Trane ES system. Submit the Bid Alternate with two options:

1. Using the existing BCU and MP5xx Controllers;

2. Replacing the existing controllers with SC/UC vintage controllers.

G. Provide a separate **Bid Alternate** to delete the local AHU LCD displays stipulated in Part 2.1.A of this specification.

H. Provide graphic screens depicting specific equipment operations. Coordinate with the Engineer of Record on key points to be included on the various graphics during the installation and throughout the Warranty period.

I. Provide a log of all calibration verifications to the Engineer of Record upon request – to include: date of the calibration; readings of the field sensor before calibration; readings of the field sensor after calibration; and the instrument(s) used to calibrate the field device (Model and serial number).

1.1 RELATED DOCUMENTS

A. The General and Supplementary Conditions and General Requirements apply to the work specified in this section—Building Automation System for HVAC (BAS).

B. Division 27 cabling requirements.

1.2 COORDINATION

A. Division 23 Mechanical Contractor shall receive, handle, mount and install automatic temperature control valves, separable wells for immersion elements and couplings for flow and pressure switches.

B. Mechanical Contractor or the sheet metal subcontractor shall install all automatic dampers. It shall be the responsibility of the mechanical Contractor or his sheet metal subcontractor to provide and install blank-off plates when the control application requires dampers smaller than duct size.

C. The direct digital portions and automatic temperature control system shall be installed by the BAS Controls Contractor.

D. Coordination of all controls items with other trades shall be the responsibility of the Controls Contractor.

1.3 TEST

A. The Control Contractor shall test the entire system and document point by point operation of all controls. Perform all required continuity testing of conductors prior to final connection to control equipment.

B. Prior to Substantial Completion, a Static Controls Validation (SCV) shall be completed. SCV shall be defined to mean that all field modules are operating, all field I/O points are operable and reading common sense values, and have been calibrated. Any points identified during the SCV that are either not reading correct values, are not present, or are in error, shall be added to the Substantial Completion Punchlist. No sequencing operations are included as a part of the SCV.

C. After Substantial Completion, a Dynamic Controls Validation (DCV) shall begin. The DCV shall be carried as a Substantial Completion Punchlist item as "to be completed." The DCV shall continue throughout the warranty period or as such time the sequencing is deemed complete in the opinion of the Engineer-of-Record.

1.4 CALIBRATION AND ADJUSTMENT

A. After completion of the installation, perform calibration and adjustments of the Automatic Temperature Control equipment provided under this contract, and supply services incidental to the proper performance of the temperature control system under the warranty below.

1.5 SYSTEM WARRANTY AND SERVICE CONTRACT

A. SYSTEM WARRANTY

All temperature control devices provided by this Contractor shall be warranted to be free of defects in workmanship and material for a period of two (2) years from the date of the job acceptance (Final Substantial Completion) by the Owner and/or date of beneficial use. Any equipment found to be defective during this period shall be repaired or replaced without expense to the Owner. This work shall be accomplished by the Contractor during normal working hours (8 am to 5 pm, Monday through Friday, excluding holidays). If sequential and/or multiple Substantial Completion dates are set during construction, then the latest Substantial Completion date shall be used as the start of the Warranty period.

B. PREVENTATIVE MAINTENANCE INSPECTIONS

Two (2) year preventative maintenance **and service** inspections shall be included within the scope of the work specified herein and shall consist of the following:

- ✓ Coverage to start at the last Substantial Completion date.
- ✓ The Controls Contractor shall be responsible for all defects or failures throughout the warranty period (parts and labor).

C. SERVICE ORGANIZATION QUALIFICATIONS:

The Servicing Contractor shall meet all of the following requirements:

1. Have certified OEM factory-trained technicians experienced on the specific equipment needing repair. Service technicians to be equipped with laptop computers.
2. Provide for two (2) hour response time, 24 hours/day, 7 days/week to inspect down equipment and then repair to make equipment operational.
3. Maintain a complete stock of OEM parts, service, and repair manuals covering types and models of equipment owned by the Owner. It is unacceptable to remove a failed device and return it to the manufacturer for repair. Parts shall be replaced by local stock at the time of service call.
4. Have fully equipped service trucks and other equipment, including that necessary to comply with prudent and regulatory environmental requirements (including CFCs).
5. Maintain software library to support building automation system. Provide and install mandatory upgrades with 30 days of issue. All systems provided shall be the most current version and all units shall be the same version.

1.6 SUBMITTAL REQUIREMENT

A. The following data/information shall be submitted for approval prior to ordering parts or beginning work at the site:

1. Complete description of operation. Include an overall system interconnect diagram showing all remote panels and power/surge protection locations.

2. Control system drawings including all pertinent data to provide a functional operating system.

3. Valve, humidifier and damper schedules showing size, configuration, capacity and location of all equipment.

4. Data sheets for all hardware and software control components.

5. A description of the installation materials including conduit, wire, flex, etc.

6. Thermostat/sensor locations.

7. Distributed panel locations.

8. Provide as part of the submittal five copies of all data.

9. Detailed point-to-point diagram of circuitry of all DDC panels, AHUs. Submit on a per distributed panel basis.

10. List of connected data points, including connected control unit and input or output device.

11. System graphics indicating monitored systems, data connected and calculated point addresses, and operator notations, as-built. Graphics shall be available for Owner and Engineer of Record review using live data via modem hook-up to the site. Not required at submittal approval time except as listed below.

12. Descriptive data and sequence of operation of operating, user, and application software.

13. Detailed documentation on the specific field equipment to be supplied by the controls Contractor shall be submitted and approved prior to installation; including, but not limited to, actuators, valves, temperature sensors, and damper operators.

14. All schemes and methods proposed to provide lightning protection entering and leaving each building shall be submitted for review and approval.

15. Locations of each control panel, gateway module, override panels on a 24” x 36” drawing or larger floor plan. Submit panel layouts for each.

16. The Owner and Engineer of Record shall have access to the proposed Graphic Screens prior to the first Substantial Completion date. It is anticipated there will be changes to the graphics throughout the Warranty period. Such changes are considered a part of the basic Scope of Work.

PART 2 PRODUCTS

2.0 HEIRARCHY

A. The control system shall consist of all three tiers:

1. Tier 1:

a. This Tier is the lowest tier and shall be located on site.

b. Binary and analog field devices and equipment components shall be interfaced to the control system at this tier.

c. Provide field modules located throughout the project selected to meet the number and type of interfaces required. No field module shall be loaded to more than 75% of its software or hardware capacity for any field data type.

d. The field modules at this tier shall be interfaced to a common communication trunk(s) shared by Tier 1 and Tier 2 modules. Data shall be shared amongst the modules and tiers using the communication trunk.

e. All tools (software and hardware) necessary to locally access, monitor, and modify these modules shall be provided to the Owner and the Engineer of Record as a part of this Scope; including, but not limited to: graphics building tools, programming tools, and local laptop software tools.

2. Tier 2:

a. The second tier shall be located on site.

b. This Tier shall communicate with Tier 1, Tier 2 and Tier 3 devices.

c. This tier shall be capable of serving Web based graphics if no third tier is provided using an Ethernet connection methology. All graphics screens available on the Tier 2 devices shall also coexist at the Tier 3 level.

d. The services required for this tier are to be provided by Trane SC controller(s). The number of SC controllers shall be provided such that the needs of the current project are satisfied with 50% remaining memory capacity and 50% field module connection capacity.

e. All tools (software and hardware) necessary to locally access, monitor, and modify these modules shall be provided to the Owner and the Engineer of Record as a part of this Scope using an owner provided basic workstation with IE browser installed.

3. Tier 3 (Enterprise Server, ES):

a. The third tier provides Enterprise Level functions consistent with that of a multi-campus owner/user. The basis of this Scope is to use the existing ES software system. The Trane ES server for this system is located at the SPC Main Data Center.

b. The Tier 3 services shall include, but are not limited to: Trending; Alarming; Graphics interface; Report Manager (Building Reports, managing reports, e-mailing reports, etc.), and messaging.

c. The ES server software shall be upgraded to the most current revision offered by the Manufacturer as a part of this Scope. Compatibility, or otherwise adverse effects, of this upgrade at other currently connected sites shall be remedied at no additional cost to the Owner.

d. All graphics screens available on the Tier 2 devices shall also coexist at the Tier 3 level.

2.1 FUNCTIONALITY

A. An operator shall be able to logon to the system using a standard web browser (IE or Safari), and without requiring system vendor-proprietary software installed on the user's PC or mobile device to allow access to all appropriate data and control functions.

B. Direct Digital Control (DDC) technology shall be used to provide the basic control functions necessary for control of systems defined for control on this project.

C. The control system shall be configured to provide a minimum of five (5) individual user profiles.

D. The control system shall accommodate simultaneous multiple user operation. Access to the control system data should be limited by operator password. An operator shall be able to log onto any computer's internet connection and have access to all designated data.

E. The Tier 1 and Tier 2 control system shall be designed such that each mechanical system will operate under stand-alone control. As such, in the event of a network communication failure, or the loss of other controllers, the control system shall continue to independently operate the unaffected equipment.

F. Communication between the control panels shall be over dedicated high-speed network (trunk). All nodes on this network shall be peers. A network communications card, embedded or discrete, shall be provided for each building control panel provided as part of the system installation.

G. All cabling of the network shall use structured cabling techniques as identified in Division 27 requirements.

H. The base system is based on a Trane Tracer ES/SC control system. Refer to the equipment schedules, flow diagrams, sequence of operation and input/output summary list as applicable to this project. The Mechanical Contractor is responsible for all coordination and scheduling of the control subcontractor. The Mechanical contractor shall include in the bid all costs (mark-ups, overhead and profit) associated with managing/coordinating the controls subcontractor.

I. The Tier 1 and Tier 2 system shall consist of a distributed processor direct digital control system utilizing electronic actuation. The system shall be fully integrated with the chillers, pumps, cooling towers and airside equipment.

J. All electric control and interlock wiring in connection with the controls and instrumentation system shall be furnished by this Contractor. Power wiring to the various control devices shall be provided by this Contractor and coordinated with the Electrical Contractor prior to Bid to ensure adequate spare dedicated circuits are available. Control power to operate VAV boxes (other than duct heaters or fan power) shall be the responsibility of this Contractor.

K. Provide a system interface and the required access to Engineering Matrix so that monitoring can be done between the project and the Engineer's office during the course of construction and throughout the warranty period. The intent is to allow the Engineer priority access during system installation, startup, demonstration and warranty period.

1. The Engineer shall also be able to use the system remotely in order to check/confirm the results of the test and balance reports in a random basis.

2. Sufficient access shall be provided to allow full programming capability; to include, but not limited to: graphics programming language, module libraries, etc. Any necessary software “tools”, graphics development packages, or other programming software packages not available on-line shall be provided to the Engineer of Record which shall return any tangible products to the Owner at the end of the Warranty period. This access shall include all Tiers of the hierarchy.

3. The Engineer shall have the highest level of BAS access available at all Tiers.

L. Integration coordination of VFDs, power meter(s), occupancy sensor and lighting control sub-system, etc., shall be the responsibility of the Controls Contractor.

M. Control Contractor shall complete all installations including electric and electronic components—not the Mechanical Contractor.

2.2 DDC PANELS (MICROPROCESSOR BASED DDC PANELS)

Provide independent, stand alone, microprocessor based control panels in order to provide centralized control of each major piece of HVAC equipment. Provide DDC panels for each air handling unit. These panels shall communicate with the operator via the Communications Network CPU/Graphics Software. Both text and graphics interface shall be provided.

A. The DDC panel shall contain the necessary hardware and firmware to interface the building input/output devices to the CPU over a communications channel.

Each DDC panel shall be a stand alone in a standard assembly packaged in a NEMA 1 enclosure complete with power supplies, card cage, interface cards and termination points. Each remote shall be capable of accepting combinations of input sensors and output controls. Each remote AHU unit shall have its’ own timeclock.

As many DDC panels as required shall be furnished to provide the monitoring and control functions and capabilities specified. The panel shall be strategically located in areas of the building that are easily accessible for maintenance and repair.

Any software edit changes in a DDC panel by the Owner shall be available to the Owner. The Owner shall not be tied to the manufacturer for those changes.

If the manufacturer's panel does not have the ability to provide the minimum point requirement, then additional panels shall be provided adjacent to the first unit in order to meet the intent of the spec. No exception to this statement shall be acceptable in order to protect the Owner's interest for future additions.

Provide at each AHU, chillers and boiler (if applicable) a dedicated DDC panel complete with LCD display and keyboard. To provide local display and adjustment of all inputs, outputs, alarm messages and setpoints. A key lock shall protect the internal DDC panel components.

Provide sufficient ROM, for operating system and PID algorithms. Protect processor cards and memory with internal grounding. Store setpoints and default parameters in a non-volatile memory (EEPROM). Battery back-up shall not be acceptable for AHU stand-alone DDC panel control. Locate the panel in the AHU room or at the AHU.

B. **INPUT/OUTPUT INTERFACE**

Each point on each interface card is to be characterized as to its point type, sensor range, status, and scale range in the on-line software data base edit. Revisions or modifications to these parameters shall be entered by the system operator through the PC keyboard.

To gather sensor data and interface with controlled equipment, the DDC panel shall use an internal multiplex design. This design shall allow each panel to accommodate different types of points using any of the following input/output options:

- Digital Input Options—Monitor the open/closed status of a switch or relay.
- Analog Input Options—Monitor analog values of voltage, current and resistance from temperature, pressure and humidity sensors, etc.
- Digital Output Options—Control on/off, start/stop relays.
- Analog Output Options—Supply voltage or current outputs to controllers.

C. **DIGITAL INPUT (DI)**

The digital inputs must be isolated contact closures and can either be normally open (NO) or normally closed (NC).

Points must be transient protected on all points to meet IEEE C37.90a-1974.

Digital input points shall monitor the open/close status of switches or relays. Digital inputs must be isolated contact closures, but normally open or normally closed contacts can be intermixed.

Monitoring voltage is 12 VDC at 12 mA per zone. Two #18 AWG wires are required per point. Points are to be transient protected to meet IEEE 472-1974.

D. **ANALOG INPUT**

The analog inputs can be voltage, current or resistance.

The analog input cards monitor values from temperature, pressure, humidity, and other analog sensors.

Analog inputs can be linear or non-linear. Points shall include a minimum 12-bit A/D converter (ADC) and an analog power supply. All points shall be wired to the input panels using wiring no less than that required by the sensor manufacturer.

Provide a minimum 12-bit ADC on all AIs.

For non-linear AI sensors, provide the inherent non-linear profile of the device (such as thermistors, non-linear CO2 sensors, etc.), the linearization table (for lookup table conversions embedded in the DDC input panel) or equation embedded in the DDC panel (for equation curve-fitting of the input signals) upon which the input is converted to engineering units. Provide the range of the sensor that corresponds to the full input range of the DDC input device.

E. **DIGITAL OUTPUT**

The digital outputs shall drive control on/off, start/stop relays which have low voltage coils. The control relays must have a minimum contract rating of 120 VAC, 5 amp, and 1/3 HP. Provide manual override switches in order to enable the operator to override the control status of each load.

F. **ANALOG OUTPUT**

The analog outputs supply voltage or current outputs to devices. The analog outputs shall be a standard 4-20 mA proportional signal. The analog output D/A conversion shall have 10-bit resolution minimum. All output points to valves shall read as a percent open.

G. **KW INPUT**

KW power inputs for all meters on site shall be provided. Inputs shall be pulse type. This Contractor shall coordinate pulse requirements with the power company and provide all necessary hardware to interface with the power company. Individual meter KW readings shall be provided as well as a sum total calculation for the site.

H. **PACKAGING AND ENVIRONMENT**

Distributed DDC panel enclosures shall be locking type, metal cabinet, with common keying. The panels have a metal print pocket suitable for storing wiring, service and log information.

The panel, when required, must functionally operate over the temperature range -30 degrees F to 120 degrees F and the humidity range 10 - 90% non-condensing. Storage temperature shall be -50 degrees F to 150 degrees F.

DDC panels shall come with a minimum of six pre-existing available knockouts for ease of wiring during installation. Panels shall have an on/off switch and shall be fused for power protection. AHU DDC panels shall be provided with the required knock-outs.

The electrical requirements shall be provided by this Contractor. Any 120 VAC requirements are to be coordinated with the Division 16 Contractor prior to bid. Power circuit to each panel shall be provided by Division 16 Contractor.

I. **FIELD PANELS (FPS)**

The Field Panels (referred to as FPs) shall be distributed standalone controller specifically designed to control the various HVAC equipment as specified herein.

Each FP shall be capable of communicating with main DDC controller panels over a twisted pair of wires. Provide at each panel an operator interface in the form of a front panel liquid crystal display with keypad. The display and keypad shall allow display and local adjustment of FPs operating parameters and setpoints.

Each FP shall have a minimum of 6 programmable/configurable PID loops.

The analog inputs shall be individually selectable for resistance inputs, 4 to 20 mA, 200 ohm input impedance and 0 to 10 VDC.

The binary outputs shall drive dry contact low coil voltage relays with normally open and normally closed (Form C) contacts. The contacts shall be rated at 120 VAC, 5 amps.

The analog outputs shall provide a continuous signal and are individually selectable as either 0-10 VDC or a 0-20 mA or 4-20 mA (both into a 500 ohm impedance).

Provide at each FP address dip switches for setting the communication link address. In addition, provide at each FP an RS 232 interface port for connection of a FP edit software for use with a portable laptop computer.

Damper operators shall be of two (2) types; modulating or two-position depending on the sequence of operation. Two-position operators shall be spring return type and the modulating operators shall be capable of accepting a 0-10 VDC or 4-20 mA signal with a gear de-engagement clutch on the operator cover. For modulating operators provide feedback potentiometer internal to the actuator for positive positioning.

2.3 TRANSIENT PROTECTION

A. All communication channels, whether in conduits or overhead runs, shall have transient suppression networks installed. The transient protection must meet IEEE standard C37.90a-1974. The suppression network shall be automatic, self-restoring and be on duty at all times.

B. Surge suppression shall comply at <u>minimum</u> with manufacturers requirements and is to include suppression on all lines entering/leaving each building.

2.4 SOFTWARE

Provide the following software features for the operation of the system:

A. PASSWORD SECURITY

The system security software shall provide the means for ensuring secure operation of the system. In doing so, the system security software shall perform the following:

1. All system editing, control operations, and alarm acknowledgment shall be subject to access authorization prior to allowing such operations to take place.

2. Defining and modifying system password and access assignments shall only be accomplished by the Building Owner, Engineer, or Designee.

3. Associated with each password shall be an access code and level of authorization.

B. APPLICATION SOFTWARE

The application software includes in general the control functions which permit the operator to control the system, and access the associated application parameters. In addition, the interaction between application programs provides the strategy for orderly management of the system as well as the following:

1. Maximum energy conservation

2. Minimum occupant discomfort

3. Unnecessary equipment cycling

All application program editing must be accessible to the Owner and the Owner's personnel who have the proper password authority. All displays necessary to create and edit the system are provided. All editing is done in English by using the menu format and by answering prompted questions. All software programming of sequences shall be done in text and shall be on-line with no intermediate compilations required.

C. PROGRAMMED SCHEDULING

The system shall provide the ability to automatically start up and shut down individual pieces of equipment by zone grouping based on a particular time of day. In addition, the ability to disable alarming and application control for a particular load as a function of the time-of-day is also required. All time programmed control will be done in accordance with the operator specified schedules.

There shall be a minimum of 32 master zone schedules of eight days each.

There shall be at least one schedule for each day of the week. The capability to schedule holidays and special days a minimum of one year in advance shall be included. The priorities of the time program functions relative to the other application programs shall be operator definable. The program shall have the capability of being down-loaded to all programmable remotes.

D. **DEMAND LIMITING AND LOAD SHEDDING**

Peak demand control shall be accomplished by monitoring the power consumption of each metered power feed device. The program shall constantly compare the actual peak demand to the operator established limits. Upon reaching limits, configurable priority loads as defined by user shall be shed on a rolling basis.

The program shall use an averaging technique that will offset the effects of demand spikes and the resultant over-shedding of loads.

The operator shall have the ability to define each load to be used for load shedding. In addition, the demand limiting program shall have as a minimum four priority groups. Each load in a particular group shall be rotated with other loads in the same group.

The program shall accommodate time of day demand limits.

There shall be a minimum of 2 time of day intervals with independent, unique limits for weekdays, Saturdays, and Sundays.

The program shall accommodate multiple meters as inputs to the software. It shall be capable of treating each independently. Associated system software shall be capable of treating them as a single sum.

E. **RUN TIME AND MAINTENANCE**

The system shall provide the ability to accumulate equipment run time for operator specified equipment.

When equipment run time exceeds an operator-specified limit, the system shall alarm the condition and print and sequentially number the maintenance order automatically for the specific piece of equipment. The system shall provide a summary of all points currently assigned to the run time program as well as their current run time values. Run time limits shall be enforceable on either an hourly or calendar date basis.

The operator shall have the ability to define or modify any of the maintenance messages to be used by the run time program.

F. **REPORTS AND LOGS**

The system shall provide management reports and logs detailing certain system performance characteristics.

The system shall have the ability to history trend a minimum of 250 different I/O or internally calculated points. The points shall be operator selectable and shall be a mix/match of the system points as selected by the operator. The operator shall also be able to select the sampling/storage trending time frequency. The minimum sample time frequency must be no greater than 10 minute intervals for 25 of the points and 5 minutes for the remaining points. A minimum of 200 samples for each point shall be trended.

The data or the trend history must be capable of being stored in a spreadsheet compatible file format (Microsoft Excel, latest version).

G. **ELECTRONIC VAV CONTROL SOFTWARE**

The system shall provide a software program to control the VAV boxes which shall have the following minimum features:

1. The VAV terminal units shall be individually controlled by a DDC VAV controller which shall be furnished by the BAS Contractor.

   The cost to ship and mount, calibrate and test the DDC equipment shall be coordinated prior to bid day and included in the BAS price.

   Sensor installation to terminal unit and communications wiring to BAS to be provided under this section. Coordination with the terminal unit provider shall be done by this Contractor prior to bid.

2. The BAS shall perform the following VAV terminal unit control strategies and provide the points as listed on the DDC/VAV point list and the specified monitoring and diagnostics.

   a. AHU Grouping—The BAS shall be able to group VAV boxes for each AHU via keyboard commands. These groups shall make it possible for the operator to send a common command to all boxes in a group to operate in the same mode. Also, each box can individually be commanded as well. BAS shall also compile on a group basis, the following:

      - ✦ Minimum group temperature
      - ✦ Maximum group temperature
      - ✦ Average group temperature

   b. Setpoint Control—The BAS shall control the zone to space temperature setpoint of each VAV box. The zone temperature setpoint shall be operator adjustable. Individual zone setpoint and control logic shall reside at the zone level, and not be dependent upon the BAS for control. In the event of communication loss, the box will continue to control the VAV damper valve to maintain current setpoints.

   c. Cooling/Heating Valve Control—The BAS shall control the cooling/heating air valve to a fully open, fully closed, maximum CFM, or minimum CFM position based on operator commands. The operator shall also have the capability to adjust the maximum and minimum airflow limits of the air valve through the BAS, as well as command each valve to a current position. Heating and cooling shall each have their own unique maximum and minimum CFM adjustable setpoints.

   d. Operating Mode—The BAS shall place the box in either the occupied or unoccupied mode based on an operator adjustable time schedule. Separate heating and cooling setpoints shall be enterable for each mode through the BAS. Other modes available for special applications shall include full open, full closed, maximum flow, and minimum flow.

e. Control Offset—The BAS shall be capable of offsetting the cooling or heating setpoints of one or more groups of boxes by an operator adjustable amount. This capability will allow for automatic zone setpoint changes based on system requirements, such as demand limiting.

f. Automatic Recalibration—The system shall automatically recalibrate its air flow sensing and air valve position measurement system at system startup, on a scheduled basis, or on demand.

g. Terminal Unit Status Report—For each terminal unit, the BAS shall provide an operating status summary of all unit sensed values (zone temperature, CFM, etc.), setpoints, and modes.

h. Terminal Unit Group Report—For each AHU group of VAV terminal units, the BAS shall report the group mode, heating or cooling, airflow, average zone temperature, minimum zone temperature, and maximum zone temperature. The report shall also display for each terminal unit in the group the present temperature control setpoints and the current zone temperature.

3. Terminal Box Diagnostics

a. If zone temperature sensor input fails above its high range, unit shall control at its maximum CFM setpoint. If sensor input fails below its low range, unit shall control to its minimum CFM setpoint.

b. If flow measuring system fails, unit shall automatically convert to a pressure dependent, damper position-based algorithm. Diagnostic message shall be displayed upon operator inquiry.

c. If communications are lost, controller shall continue to operate in the current mode of operation. All setpoints shall be retained in nonvolatile memory. If communications are not restored within 15 minutes, unit shall automatically initiate a reset-recalibrate.

4. Cooling Mode VAV Terminal Sequence:

a. On a rise in space temperature, the unit shall modulate up toward its maximum CFM.

b. On a drop in space temperature, the unit shall modulate toward its minimum CFM.

5. Heating Mode VAV Terminal Sequence:

a. On a rise in space temperature, the unit shall modulate down toward its minimum CFM.

b. On a drop in space temperature, the unit shall modulate toward its maximum CFM.

6. The control system shall include the capability of operating all of the VAV boxes and VAV air handlers in "Critical Zone Reset" mode. Supply air temperature of the AHU shall be reset via average AHU group space temperature.

H. **GRAPHICS GENERATION PACKAGE**

1. Provide dynamic color graphics. Use text fields generally to indicate status. Any elements on the graphics that are moving to indicate status shall also be provided with text status as well (ex: using a dynamically circulating fan element to indicate status of the fan shall be accompanied with an appropriate ON/OFF text status). The intent is to allow screen snapshots at a moment in time to be taken and the status of all elements on the graphic screen may be easily discerned.

2. Dynamic Graphic Software

   a. Provide as part of this program an automatic refresh rate for all graphic displays. The automatic refresh rate shall be no less than (20) seconds for all system points being displayed. A graphic mode's pop-up menu shall be provided for accessible selection of available functions in a tiered top/down structure.

3. Color Graphic Display Linkage Editor

   a. Provide, as part of the basic Scope of Work a graphics generation program, a color graphic display linkage editor which assigns ("links") the appropriate graphic display files to the correct screen graphics. The linkage editor shall also provide the operator with the ability to define the display sequence that is followed when the next and previous function keys are utilized.

4. Graphic Requirements

   As a part of the requirements of this section, provide a series of logically ordered dynamic graphics as described in paragraph H.1 for each BAS remote. There shall be as a <u>minimum</u> a dynamic graphic for each of the following:

   a. Site Plan Graphic

      Provide a site plan of the project indicating location of chiller plant, major mechanical equipment, PCs, and electric power meter(s). The site plan graphics shall also have easily identifiable ICONS and target points.

   b. Air Side

      1) Air Handling Units - Constant Volume

         - Fan start/stop control
         - Fan status (On/Off)
         - Filter DP
         - Return air temperature Deg.F.
         - Supply air temperature Deg.F.
         - Space temperature Deg.F.

- Space temperature setpoint Deg.F.
- Chilled water valve % open
- Heating water valve % open
- Cooling coil discharge temperature Deg.F.

2) Air Handling Units – Variable Volume

- Fan status (On/Off)
- Filter DP
- Static Pressure (In.WG)
- Supply air temperature Deg.F.
- Chilled water valve % open
- Heating water valve % open
- Return air temperature Deg.F.
- Supply air temperature setpoint Deg.F.
- Static pressure setpoint Deg.F.
- Cooling coil discharge temperature Deg.F.
- Outside air CFM
- Outside air damper % open
- Return air damper % open

3) VAV Boxes

- Space temperature Deg.F.
- CFM max setting (heating/cooling)
- CFM min setting (heating/cooling)
- Cooling setpoint Deg.F. (occ/unocc)
- Heating setpoint Deg.F. (occ/unocc)
- Air valve % open

- ➔ Delivered CFM
- ➔ Fan status (on/off)
- ➔ HW heating coils (valve open/closed)

c. Chiller Plant Graphics Group

The chiller plant graphics group shall consist of dynamic graphics for the following new equipment:

1) Cooling Tower

- ⇨ Outdoor air temperature Deg.F.
- ⇨ Condenser water entering temperature Deg.F.
- ⇨ Condenser water leaving temperature Deg.F.
- ⇨ Fan (on/off)
- ⇨ VFD control and status

2.5 AUXILIARY CONTROL DEVICES

A. AUTOMATIC CONTROL DAMPERS AND OPERATORS

1. Automatic control dampers shall have interlocking blades and frames. Dampers shall be designed and constructed so that the blades, frames and linkage mechanism shall present a rigid assembly with free and easy action. Dampers shall be of galvanized steel blades and welded steel frame. The damper bearings shall be brass or oil impregnated nylon with brass bearing shafts. Where the damper blades are installed in a vertical position, a thrust type ball bearing shall be provided for the lower bearing. All bearings in ducts or casings to the outside shall have the top and bottom edges on both ends trimmed with replaceable neoprene seal fastened in an approved manner, so as to be practically air tight when closed. Closed dampers shall have leakage of not more than one-half percent at 4" of water column (10.2 cm) static pressure and 2,000' per minute velocity.

2. Submit leakage and flow characteristics of dampers to Engineer to specify performance. Test leakage reports shall be in accordance with AMCA standard 500-75.

3. When dampers are located at fan discharge they shall be designed to operate properly without fluttering, at velocities up to 4,000 fpm and against a static pressure differential developed by the fan. Maximum deflection shall be no more than 1/50 of the unsupported span distance. Each automatic damper or section of damper if too large for one motor shall be operated by the required number of modulating motors. The motors shall be of the proper size required to operate the damper with uniform and gradual movement and shall return the damper to the same position for a given signal during an opening or closing movement of the damper. Damper operators shall be of the proportional type capable of accepting 0-10 volts or 4-20 mA control signal and 2-10 VDC feedback signal. The type of operator input signal will be a function of the DDC control panel output.

4. Damper operators shall include spring return, a 0 – 5 VDC feedback signal, and shall be sized a minimum of 125 percent of the highest actual close-off operating pressure of the system (25% safety factor). Contractor shall provide feedback wiring, terminations, graphics, and control logic connected to DDC input board (analog signal), on all outside air dampers on 100% outdoor air handling units wherever it applies to this project, for positive feedback of damper position.

5. Approved damper manufacturers are: Safe-Air and Ruskin.

6. The Control Contractor shall furnish all the controlled dampers of the type and sizes indicated on the Drawings for installation by the sheet metal subcontractor.

7. All 2-position control dampers shall be sized for minimum pressure drop, at the specified duct size.

8. All modulating dampers shall be sized for an effective linear air flow control characteristics within the angle of rotation and maximum pressure drops specified. Information shall be provided to the sheet metal subcontractor for determining the proper duct reductions or baffles used.

9. Damper frames shall not be less than 13 gauge galvanized steel, formed for extra strength, with mounting holes for enclosed duct mounting.

10. All damper blades shall be of not less than 16 gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over 8" in width. Blades shall be secured 1/2" diameter zinc plated axles by zinc plated bolts and nuts. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade linkage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

11. Dampers shall be suitable for operation between -40 F and 200 F. The Control Manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

12. Dampers shall be of the parallel blade design for 2- position service and opposed blade design for modulating service.

13. Approved damper operator manufacturer: Belimo.

B. **AUTOMATIC CONTROL VALVES AND OPERATORS**

1. The Control Contractor shall furnish all the control valves of the type indicated on the drawings for installation by the Mechanical Contractor.

2. All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. All modulating three-way mixing valves shall be provided with linear V-port plugs or equal percentage flow characterized ball valve type, such that the total flow through the valve shall remain constant regardless of the valve's position. All diverting valves shall have two V-port plugs.

3. Valves 2" and smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2" and larger shall have iron bodies brass or bronze trimming with flanged ends. Valves shall be factory rated to withstand the pressures encountered. Valves shall have stainless steel stems and spring loaded Teflon packing.

4. Air handling unit water valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi. Valves shall have replaceable seats and discs or equal percentage flow characterized ball valve type. Valves and operators shall be capable of close-off pressures equal to or exceeding the dead head pressure of the largest pump within the system or 60 psi, whichever is greater and shall be sized a minimum of 125 percent of the highest actual operating pressure of the system (25% safety factor).

5. All automatic control valves shall be fully modulating type unless specified otherwise in the Sequence of Operations or on the drawings.

6. All control valves shall be designed to fail as follows:

   ⌦ Cooling - Fail fully open to coil

   ⌦ Heating - Fail fully closed to coil

7. Each valve operator shall be 4-20 mA type, with spring return and a 0 – 5 VDC feedback signal. Contractor shall provide feedback wiring, terminations, graphics, and control logic connected to DDC input board (analog signal), on all automatic control valves in the chiller plant and/or heating plant (except at air handlers) wherever it applies to this project, for positive feedback of valve position.

8. Operators shall be by Belimo.

C. **DIFFERENTIAL PRESSURE SWITCHES**

1. Differential pressure switches shall be furnished as indicated by the sequence for status purposes for either air or water applications. Provide single pole double throw switch with fully adjustable differential pressure settings. The switch shall have a snap-acting Form C contact rated for the application. The switch contact shall be rated for 5 amps at 120 volts as a minimum. Units shall be selected for ranges consistent with the application and shall be submitted for the Engineer’s approval.

   a. Dwyer and Cleveland products are acceptable manufacturers.

D. **ELECTRONIC TEMPERATURE SENSORS**

1. For water applications (hot water, chilled water, glycol mixed in water, and steam applications). Provide:

   a. 100 Ohm thin-film Platinum RTD sensors in thermowells, UON.

   b. Sensors shall be directly interfaced into the Tier 1 devices.

   c. Provide interface wiring with no splices from sensor leads to input panel(s).

   d. Stipulate Minimum configuration spans that correspond to the full ADC input range. No less than .1 Degrees per state of resolution (configured span / distinctly different transition states discernable from the ADC) shall be used.

2. For room sensing and air temperature sensing applications, provide:

   a. Sensors shall be calibrated to less than or equal to a 1/4 degree F resolution for the specific application. Thermistor sensors are approved for VAV zone or room sensing only. Substitutions must be approved by the Engineer.

   b. All sensors to be field calibration verified and if adjustments are necessary, they shall be configured in software.

   c. Document field sensor calibrations…refer to Part 3.

3. 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 2.5 m or 5 m as required.

4. Insertion elements for liquids shall be with brass separable socket (thermowell) with minimum insertion length of 2-1/2 inches (60 mm) or suitable for small line sizes. No strap-on sensors shall be allowed.

5. Supply room sensors with tamper proof cover.

6. Provide outside air sensors with watertight inlet fitting, shielded from direct rays of sun, mounted on the North side of the facility.

7. Provide a battery operated, portable temperature sensor at the job site to be used The transmitter/sensor shall be field calibrated by the Installing Contractor to transmit a 4-20 mA signal at the corresponding temperature ranges. The Installing Contractor shall calibrate transmitter in field with a precision grade substitution resistance box and two (2) decimal place minimum digital ammeter test circuit. Test transmitter at three (3) temperature points minimum. Engineer will spot check verify these calibrations during walk through inspection.

8. Wall mounted sensor shall be mounted at 5'-6" above finished floor in an area which free air current is not constricted or blocked, final location shall be approved by the Owner and Engineer prior to installation.

E. **ELECTRONIC STATIC PRESSURE SENSORS**

1. Static pressure sensors shall be differential pressure sensors, with the "high" output sensing the duct pressure and the "low" input sensing the atmospheric pressure.

2. The range for the static pressure sensor shall be matched to the static pressure of the system being sensed, 0 to 0.5 inches, 0 to 2 inches, 0 to 5 inches, or 0 to 10 inches.

3. Accuracy shall be plus or minus 2% of the full range being sensed.

4. BAPI pressure sensor with digital read-out display.

F. **THERMOSTATS (STAND-ALONE TYPES)**

1. Two position (On/Off) room thermostat with bimetallic sensing element, setpoint thumbwheel dial, room temperature indicator, surface mounting base, and hard plastic coverplate, UL listed as manufactured by Barber Coleman, Series TC, or equivalent by Honeywell or RobertShaw.

G. **HUMIDITY SENSOR/TRANSMITTER**

Provide relative humidity sensor/transmitter where shown on the control drawings. Sensor and transmitter shall have:

System Accuracy ..... ±2% RH @ 25ºC from 20-95% RH

Output Signal ..... Two wire 4-20 mA linear, proportional to 0-100% RH

The transmitter power shall be compatible with and powered by, the low voltage power supplied by this Contractor.

H. **CARBON DIOXIDE GAS SENSOR/TRANSMITTER**

Provide carbon dioxide gas sensor/transmitter where shown on the control drawings. Sensor/transmitter shall meet the following specifications:

Measurement Range ..... 0 to 5,000 ppm

Accuracy ..... ±5% full scale

Response Time ..... Less than one (1) minute

Output Signal ..... 4-20 mA

Output Impedance ..... 100 Ohms

Repeatability ..... ±20 ppm

Drift ..... ±100 ppm per year

Calibration Adjustments ..... Offset and span

MINIMUM REQUIRED

Calibration Interval.....One (1) year

Operating Temp. Range.....0 to 50ºC

Operating Humidity Range.....5-95% RH non-condensing

Power Requirement.....20-30 VAC, 60 Hz or 20-30 VDC, 400 mA max.

Current Requirement.....200 mA average, 500 peak

Operating Elec. Environment.....Floating or Grounded

Dimension (HxWxD).....4" x 7.5" x 3"

Unit Enclosure Material .....UL Fire Rated

Accessories .....Calibration Kit & Instructions

Manufacturer.....Gaztech International Corp. or pre-approved substitute

I. **OUTSIDE AIR MONITOR AND CONTROL**

1. Provide for each of the VAV air handling units an airflow control center capable of performing the following functions: constant volume control of outside air. The intent is for the controls required to perform this function to be an integral part of the Building Management and Automatic Temperature Control System.

2. Each airflow monitor and control station shall be complete with velocity pressure transmitter and air volume flow rate control.

3. The major control instruments shall be of industrial process control quality and shall be capable of the following minimum performance:

   a. Differential Pressure Transducer: The differential pressure transducer shall be capable of transmitting a linear 4 to 20 milliamp output signal proportional to the differential (velocity) pressure input signals within the following performance and applications criteria.

      (1) Calibrated Spans .....not greater than 1-1/2 times the maximum design velocity pressure.

      (2) Calibrated Accuracy.....±1.0% of span.

      (3) Repeatability .....±0.05% of output.

      (4) Hystersis .....±0.025% of span.

      (5) Linearity.....±0.2% of span.

      (6) Stability.....±0.2% drift/year.

      (7) Operating Range of Sensor .....32°F to 150°F.

(8) Operating Range of Transmitter ...32°F to 150°F.

(9) The transmitter output shall be unaffected by direction (or attitude) of mounting or external vibrations, and shall be furnished with a factory calibrated span.

J. **AIRFLOW MEASURING STATIONS (DUCT AIRFLOW MEASURING DEVICE)**

1. Each device shall be designed and built to comply with, and provide results in accordance with accepted practice as defined for system testing in the ASHRAE Handbook of Fundamentals as well as the Industrial Ventilation Handbook.

2. Airflow measuring stations shall be fabricated of heavy galvanized steel welded casing with 90^{O} connecting flanges in a configuration and size equal to that of the duct it is mounted into. Each station shall be complete with an air directionalizer and parallel cell profile suppresser across the entering airstream and mechanically fastened to the casing, equal-area and equal-weighted averaging total pressure sensors and manifold, bullet-nose shaped static pressure sensors with averaging manifold, internal piping, and external pressure transmitter ports. An identification label shall be placed on each unit casing listing model number, size, area, and specified airflow capacity.

3. The maximum allowable pressure loss through the unit shall not exceed .1" W.G. Each unit shall be capable of measuring the airflow rate within an accuracy of 2% as determined by U.S. G.S.A. certification tests and shall contain a minimum of one total pressure sensor per thirty-six square inches of unit measuring area.

4. Stations shall be installed in strict accordance with the manufacturer's published requirements. These stations serve as the primary signals for the airflow control systems, therefore it shall be the responsibility of the Contractor to verify location and installation to assure that accurate primary signals are obtained.

5. The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

6. Airflow measuring station shall be Model FAN-E as manufactured by Air Monitor Corporation, or pre-approved substitute. Refer to schedules and floor plans.

K. **VARIABLE FREQUENCY DRIVE (VFD) MOTOR SPEED CONTROLLER** (Refer to Specification Section 23 29 23 and Drawings for Voltage, Size, and Location found on Equipment Schedules)

L. **CONTROL WIRING**

1. All conductors shall be of stranded copper wire.

2. All EMT/conduit and outlet boxes shall conform to the requirements specified under Division 27, Communications.

3. All cables run exposed in return air plenums shall be smoke rated for the application. Do not run wire in drywall without conduit.

4. All wiring cables shall have 600 volt insulation.

5. Cables shall be properly identified/tagged as to the control point.

6. All cables from ceilings to wall temperature sensors shall be installed in conduit (EMT).

M. **DIFFERENTIAL PRESSURE TRANSMITTER/ORIFICE FLOW STATION**

1. Transmitter: Provide a Rosemount Model 1151DP Alphaline Flange-mounted Differential Pressure Transmitter with all necessary installation hardware (seals, flanges, etc.). Unit shall be mounted at eye level for ease of calibration. Contractor shall calibrate instrument for 4-20 mA output (input into building control system). Coordinate the transmitter range with the requirements of the mechanical system prior to submitting shop drawings. The mounting flange shall be 150 psi rating class, 316 stainless steel. Sensor module and low side materials shall be 316 stainless steel. The high pressure side process fill shall be capable of air operating range of 0-200°F. Provide unit with LCD display, 0-100%. This Contractor shall provide power as required. Make all final piping connections to transmitter.

2. Orifice Plate: Furnish and install as shown on plans, a cast iron wafer-type flow meter designed for low pressure drop operation. The flow meter will be equipped with brass readout valves (with integral check valve) for taking differential pressure readings across the orifice of the flow meter. The flow meter shall be designed to operate at a maximum working pressure of 300 psig at 250°F. The flow meter must be furnished with a calibrated nameplate for determining an accurate system flowrate. Each flow meter shall be ITT Bell & Gossett Circuit Sensor Flow Meter Model No. OP-4A or approved equal.

N. **WATER FLOW METER**

1. Furnish turbine flow or magnetic flow sensors complete with hot tap full port ball valve and installation hardware. Paddle type rotors will not be acceptable. Turbine flow sensors shall be dual-turbine UON on the documents. Each sensor shall be individually calibrated and tagged accordingly against the manufacturers primary standards which must be accurate to within 0.1% traceable to the U.S. National Institute of Standards and Technology (NIST).

2. The sensor shall have a maximum operating pressure of 400 PSI, maximum operating temperature of 220 degrees F, (optional 300 degrees F) and a pressure drop of less than 1 PSI at 17 feet per second flow rate. Flow sensor shall have 100: 1 turndown ratio. Accuracy shall be + 2% of actual reading from 0.4 feet per second to 20.0 feet per second.

3. The sensor shall have integral analog outputs of 0 to 10 vdc and 4-20 m A current output for connection to the DDC system. All sensor outputs to the DDC field panels shall be linear with flow.

4. Install per the manufacturer's requirements. See Part 3 of this specification for further details.

O. **CURRENT SWITCHES**

1. Provide a solid state switch which when the current level sensed by the internal current transformer exceeds the adjustable trip point. Internal circuits are to be totally powered by induction from the line being monitored. Provide a zero off-state leakage in the solid-state relay output, while switching both AC and DC circuits. Provide an LED that will show three pieces of information (Rapid Flashing-switch is tripped, Slow Flashing-current is present but below the trip point and no Flashing-current is either off or below the bottom of the range) and permits setting the trip point adjustment prior to system connection.

P. **FILTER STATUS TRANSMITTER**

1. Provide filter status for all central station air handling units. The transmitter shall have both visual monitoring and electronic control of very low differential pressure. The transmitter shall have 4-20ma output signal to be used by the DDC system. Fan coil units shall not have filter status unless the Engineer recommends it.

2. Transmitter shall be Dwyer series 605, BAPI Series ZPS, or Setra Series 260.

Q. **FIRESTATS**

1. Provide UL-listed fire protection thermostats where indicated in main supply and return air ducts of air handling units which are rated less than 2,000 cfm. Connect thermostats which are capable of stopping fans in event of excessive temperatures in fan control circuits. Provide thermostats with fixed or adjustable settings to operate at not less than 75 F above normal maximum temperature at their location in the air handling system. Comply with requirements of NFPA 90A. Provide thermostats with the following operating features:

   a. Provide manual reset type thermostat.

R. **MAKE-UP WATER METER**

1. Furnish an approved single turbine flow sensor complete with hot tap full port ball valve and installation hardware. Paddle type rotors will not be acceptable. Rotational sensing of the turbine shall be accomplished electronically by sensing impedance change and not with magnetic or photoelectric means. Each sensor shall be individually calibrated and tagged accordingly against the manufacturers primary standards, which must be accurate to within 0.1% traceable to the U.S. National Institute of Standards and Technology (NIST).

2. The sensor shall have a maximum operating pressure of 227 PSI, maximum operating temperature of 250 degrees F, (optional 300 degrees F) and a pressure drop of less than 1 PSI at 17 feet per second flow rate. Flow sensor shall have 32: 1 turndown ratio. Accuracy shall be +/- 1% of actual reading from 0.4 feet per second to 20.0 feet per second.

3. The sensor shall have integral analog outputs of 0 to 24 vdc and/or 4-20 m A current output for connection to the DDC system. The sensor shall also include an internal frequency output consisting of 0 to 15 VDC pulses for diagnostics purposes and for connection to peripheral equipment (local display, BTU meter, etc.). All outputs shall be linear with flow.

4. The turbine element shall have EDPM o-ring seals. be made of polypropylene (optional polsulfone) with sapphire jewel bearings and tungsten carbide shafts. The flow sensor shall be constructed of Brass for sizes ¾"- 1½" and Epoxy coated cast iron for sizes 2"-10" with aluminum electronics enclosure and gasket cover.

5. Basis of Design is Niagara Model 860 (MTX or WPX depending on size) with digital pulse transmitter module.

PART 3 INSTALLATION

3.1 CONTROL WIRING

A. Provide conduit and outlet boxes consistent with Division 27 requirements.

B. Install remote push-button stations and/or control devices interposed in the control wiring.

C. Provide over-current protection for all control and interlock wiring as specified in NFPA (70.1971) Art. 240-5 (a), Exception #4 and Art. 430-72, Exception.

D. Line voltage and exposed low voltage control wiring shall be run in conduit. Exposed shall be defined to mean visible from within the occupied spaces (including inside equipment rooms).

E. No splices from the field sensors to the DDC field panels will be allowed. If splices are used, they must be at junction boxes and control centers and the controls provider shall provide the Engineer of Record line loss calculations that ensure the ADC converter in the field panels will not be skewed more than .1% of the full input range of the field panel.

F. No two wires of the same color shall be run in one conduit unless wires of the same color are properly tagged at both ends and any splice points. Do not change colors at splice points.

3.2 INSTALLATION

A. The control sequences indicated in the specifications herein show the intended sequences of operation of the various control systems and shall be followed completely, deviations are not acceptable. Control sequences are intended to be conceptual and not prescriptive. Non-stipulated support sequence elements shall be considered as a part of the concept sequences and shall be provided as a part of this specification.

B. Each control system shall be complete with all necessary thermostats, valves, relays, switches, accessories, etc., and all interconnections, and so arranged that they will provide the proper automatic sequence of operation between the various control devices as required to maintain the desired temperature, conditions and sequences.

C. All control equipment shall be fully modulating unless otherwise noted, and relays or accessories not specifically mentioned but required for proper operation shall be included.

D. The system shall be installed by competent mechanics and electricians regularly employed by the controls Contractor. Installation by mechanical Contractor is not acceptable.

E. Control and instrument wiring and capillaries are to be secured to building structure—not to ductwork. The exact location of instruments, panelboards, accessories, etc., not definitely located shall be approved by the Architect/Engineer.

F. Field verify all temperature, relative humidity, and carbon dioxide sensors. Provide a log of all calibration verifications to the Engineer of Record upon request – to include: date; readings of the field sensor before calibration; readings of the field sensor after calibration; and the instrument(s) used to calibrate the field device (Model and serial number). The controls contractor shall provide reasonable calibration verifications at the request of the Engineer of Record.

G. All automatic controls and accessories shall be located in accessible locations.

H. All non-panel, as well as panel mounted instruments, shall be clearly labeled as to use and system served by means of engraved laminated nameplates.

I. Where control instruments or accessories are to be installed on covered casings, ductwork, etc., they shall be mounted on the finished surface of the covering. Care shall be taken that there are no leaks around the stems where they pass through the metal work.

J. All modulating control valves, dampers, etc., shall operate in a slow, gradual manner without any jerking or slamming.

K. All controls shall operate satisfactorily without any cycling or hunting. The manufacturer shall furnish any necessary additional controls, relays or damping devices as required to correct cycling or hunt that occurs in any part of the control system after the system is in operation.

L. Automatic control manufacturer shall provide power to all electric actuators requiring external power source whether they are furnished by him or part of other equipment.

M. Electronic VAV controllers, motors, and sensors shall be provided under this scope of work. The control Contractor shall also include the cost of mounting controllers and motors by the VAV box manufacturer in his price.

N. The Automatic Control Contractor shall furnish all motorized valves and dampers to the Mechanical Contractor for installation.

O. Water and BTU Flow meters shall be installed per the Manufacturer's requirements. The installation shall not be installed in such a manner as to reduce the Manufacturer's published accuracy and turndown ratios.

1. Should sensors be installed in line sized pipe, then the pipe shall be provided with reducers/expanders to maintain the Manufacturer's stated accuracy and turndown performance. The controls provider shall coordinate with the Mechanical provider to ensure this requirement is met.

2. Up and downstream piping installation requirements to meet the Manufacturer's accuracy and turndown ratios shall be coordinated with the Mechanical provider.

P. Provide pre-configured Reports to document Baseline sequence operations:

1. All lighting sensor points set up by AHU zone of control;

2. Advanced control algorithms – one for each algorithm for each AHU;

3. Integration devices – one for each integrated device (points to be reported shall be coordinated with the Engineer of Record.

Q. Provide Trend point data for all points, real or virtual, at 5 second intervals.

3.3 CONTROL MANUFACTURER'S FIELD SERVICES AND INSTRUCTIONAL REQUIREMENTS

A. Controls Validation Support:

There shall be two levels of control system validation support: Static Controls Validation and Dynamic Controls Validation.

The intent of the Static Controls Validation (SCV) is to ensure the field devices are properly installed; signals being read by the DDC system; sensed values are being reported at both the Field Panel and Enterprise level; and the reported values are properly calibrated. The SCV shall be completed prior to Substantial Completion of the project.

The intent of the Dynamic Controls Validation (DCV) is to ensure the equipment is being properly sequenced and a friendly Human Machine Interface (HMI) is being provided. The DCV shall continue throughout the Warranty period.

B. On-site Training:

On-site training shall be provided for up to 7 of the Owner's representatives (6 staff members and the Engineer of Record). On-site training shall not begin until the SCV has been completed, the graphic screens are operational, and the HMI deemed acceptable to the Engineer of Record.

This training shall be completed in groups of no more than 4 persons per group at one time in one 4-hour session for each group. The training shall focus on the specific installation and shall address both hardware and software. This training shall be completed after local training and after substantial completion. Specific as-built documentation for this project shall be used for reference as a part of this training. Pre-submit course outline to Engineer as stated above.

C. For all levels of training, a sign-off sheet shall be submitted to the Engineer certifying that each individual has completed such training to acceptance of individual. Hours of instruction received shall be a part of the sign- off sheet.

D. It shall be the Owner's responsibility to provide adequate time for attendance at all training sessions.

3.4 DEMONSTRATION

A. General: Provide field testing and adjustment of the complete EMCS and on-site, operational acceptance test of the complete operational EMCS. The Owner may witness all tests.

B. Field Test: When installation of the system is complete, calibrate equipment and verify field module communication before the system is placed on line. All testing, calibration, adjusting, and final field tests shall be completed by the Controls Manufacturer. Provide a cross check of each control point within the BAS. Verify that all systems are operable from local controls in the specified failure mode upon BAS communications failure or loss of power. Verify that all systems return to BAS control automatically upon resumption of BAS operation or return of power.

C. The punchlist items shall be corrected by the Installer to the satisfaction of the Engineer within a two (2) week period.

3.5 ACCEPTANCE AND WARRANTY

A. When the system performance is deemed satisfactory and all record (as-built) drawings have been received by the Owner, that part of the system shall be accepted for beneficial use and shall be considered complete.

B. All control hardware, software, and firmware delivered to the Installer by the Controls Manufacturer shall be warranted by the Controls Manufacturer throughout the Warranty Period. Defects arising during this warranty period shall be corrected without cost to the Owner.

PART 4 SEQUENCE OF OPERATION

A. Refer to the drawings for Sequence of Operation.

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SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and hydronic specialties for the following:

1. Pre-insulated Underground pipe and fittings.
2. Hot-water heating piping.
3. Chilled-water piping.
4. Condenser-water piping.
5. Glycol cooling-water piping.
6. Makeup-water piping.
7. Condensate-drain piping.
8. Blowdown-drain piping.
9. Air-vents and Air-vent piping.
10. Safety-valve-inlet and -outlet piping.
11. Air Separators
12. Strainers.
13. P/T Plugs.
14. Calibrated Balancing Valves.
15. Relief Valves.
16. Suction Diffusers.
17. Thermometers.
18. Pressure Gauges.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

2. Division 23 Section "Hydronic Piping Specialties" equipment and accessories for hydronic piping systems.

3. Division 23 Section "HVAC Water Treatment" flushing, cleaning and chemical water treatment for hydronic piping systems.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled-Water Piping: 150 psig at 200 deg F (93 deg C).

2. Hot-Water Heating Piping: 150 psig at 200 deg F (93 deg C).

3. Chilled-Water Piping: 150 psig at 200 deg F (93 deg C).

4. Condenser-Water Piping: 150 psig at 200 deg F (93 deg C).

5. Glycol Cooling-Water Piping: 150 psig at 200 deg F (93 deg C).

6. Makeup-Water Piping: 150 psig at 200 deg F (93 deg C).

7. Condensate-Drain Piping: 150 psig at 200 deg F (93 deg C).

8. Blowdown-Drain Piping: 200 deg F (93 deg C).

9. Air-Vent Piping: 200 deg F (93 deg C).

10. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.

2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

3. Air control devices.

4. Flushing, cleaning and chemical treatment methodology, products, equipment and procedures including begin and end schedule.

5. Hydronic specialties.

6. Pipe, Fittings and Field Insulation Methodology

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings: Detail, at 1:20 scale (or as appropriate for representation of details), the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

D. Welding certificates.

E. Qualification Data: For Installer.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

H. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 PRODUCTS

2.1 PRE-INSULATED UNDERGROUND PIPE AND FITTINGS

A. General

1. Factory fabricated, pre-insulated piping system shall be used underground for chiiled water service, using a welded jointing method.

2. Unless otherwise specified, all pipe, fittings, valves, and accessories shall conform to the requirements of ANSI B31.1, and shall be of the proper type for pressure and temperature of the water systems.

B. Carrier pipe

1. Carrier pipe shall be ASTM A-53 ERW, Grade B, butt weld, standard weight.

2. All pipe cut to length in the field and fittings shall be protected from water and dirt damage by installing rubber end seals or factory fabricated PVC caps over the casing and carrier pipe sealing the ends completely from exposure. In no case shall open ends of fittings or pipes be left exposed to the environment either in the field or en route.

C. HDPE Casing Pipe

1. Seamless High Density Polyethylene (HDPE) conforming to ASTM D1248. Piping wrap shall be heat shrunk at closures.

2. Minimum jacket thickness shall be in accordance with insulation thickness table.

D. Insulation

1. Insulation shall be Polyurethane foam and shall meet the following specifications:

a. Type: Two component urethane

b. Compressive Strength: 25 psi parallel min. at 5% comp.

c. Shrinkage: None at 70 F.

d. Free Rise Density: 2 to 3 lbs/cubic foot.

e. Aged "K" (70°F - 72 hrs): 0.14 @75 F BTU per inch per hour, per degree Fahrenheit, per square foot.

f. Closed Cell Content: 90-95% in conformance with ASTM 1784 completely filling the annular space between carrier pipe and jacketing.

g. Minimum thickness shall be per Insulation Thickness Table.

E. Casing Coupling

1. The casing coupling shall be HDPE meeting classification requirements of ASTM D1248. The coupling shall be SDR 51 or heavier in accordance with ASTM D2241. Insulate at each coupling with polyurethane foam to fill annular space between carrier pipe and casing.

2. Method of sealing the couplings shall be as follows:

   a. Slip the casing coupling over the joined pipe sections. The casing coupling shall then be wrapped with heat shrink material in the field to provide a watertight seal (minimum thickness of exterior wrap shall be 60 mils).

F. Fittings

1. Fittings shall be pre-insulated by the piping system manufacturer using the same insulation thickness and casing as the pipe.

2. All fittings and expansion fittings shall be fabricated as detailed on drawings.

3. Field insulation of fittings utilizing factory approved insulation kits is also acceptable. PVC sleeve extenders and fitting covers shall be sealed with heat shrink tape after insulation of fitting is complete. Fitting cover shall be completely wrapped from one end to the other with heat shrink tape.

G. Penetration Sleeves

1. Provide where piping passes through masonry or concrete walls, floors, and roofs.

2. Sleeves in outside walls below and above grade, in floor, or in roof slabs, shall be schedule 40 or standard weight coated black steel pipe.

3. Space between piping or insulation casing, and the sleeve shall be sufficient to allow proper water tight sealing, but never less than 1/2".

4. Sleeves shall be held securely in proper position and location during construction.

5. Sleeves shall be of sufficient length to pass through entire thickness of walls or slabs. Sleeves in floor slabs shall extend 2 inch above the finished floor.

6. Refer to drawings for details.

H. Penetration Seals

1. All penetrations shall be sealed to prevent water from entering the building. (Refer to details on drawings.)

I. Insulation Thickness Table

1. Thickness of insulation for pre-fabricated insulated pipe and fittings shall be as follows:

NOMINAL PIPE SIZE IN INCHES	MINIMUM INSULATION THICKNESS IN INCHES	JACKET SIZE IN INCHES	JACKET THICKNESS IN MILS
1	1.91	5.4	125
1.5	1.62	5.4	125
2	1.38	5.4	125
2.5	1.77	6.7	125
3	1.46	6.7	125
4	1.96	8.7	125
6	1.98	10.85	125
8	1.95	12.85	150
10	1.52	14.12	150
12	1.53	16.14	150
14	1.88	18.22	150
16	1.92	20.3	175
18	1.90	22.3	175

J. Dimensions

1. The pre-fabricated insulated piping shall be furnished in 20' random lengths.

K. The pre-fabricated insulated piping system shall be as manufactured by Rovanco Corp., Thermal Pipe Systems, Inc., Ricwil, Thermacor Process, Energy Task Force, or Insultek.

L. Anchors: Anchors shall be 1/4" thick plate steel and extend 2-1/2" beyond the casing diameter. Anchors shall be pre-fabricated (attached to steel pipe) and sealed to pipe jacketing with pipe manufacturers standard anchor insulation kit. Location of anchors shall be a part of shop drawing submittal for approval by the Engineer. Anchor assembly shall be poured in concrete block by Contractor in field. Concrete blocks shall generally extend 12" in all directions from the anchor and rest on undisturbed earth.

M. Provide shop drawings of underground piping system, calculate, provide and show all expansion loops required for expansion and contraction of piping system. Shop drawings shall indicate depth of pipes required for system. Coordinate depth with all other trades and show on shop drawings all locations of underground utilities which may pose a conflict or require special care during installation. Expansion/contraction compensation will be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops, and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings are used with all fittings having expansion in excess of 1/2".

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

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

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Anvil International, Inc.

b. S. P. Fittings; a division of Star Pipe Products.

c. Victaulic Company of America.

C. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

C. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.

2. End Connections: Butt welding.

3. Facings: Raised face.

4. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

D. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Hart Industries International, Inc.

d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150 minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

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

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

3. Separate companion flanges and steel bolts and nuts shall have 150 psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

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

a. Calpico, Inc.

b. Lochinvar Corporation.

G. Dielectric Nipples:

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

a. Perfection Corporation; a subsidiary of American Meter Company.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Company, Inc.

d. Victaulic Company of America.

2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, and 300-psig minimum working pressure at 225 deg F.

2.6 VALVES

A. Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

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

a. Armstrong Pumps, Inc.

b. Tour & Andersson; available through Victaulic Company of America.

c. Macon

d. Oventrop.

2. CWP Rating: Minimum 125 psig.

3. Maximum Operating Temperature: 250 deg F.

4. Furnish and install, as shown on plans and with manufacturer’s recommendations, Model CBV-T threaded type circuit balancing valves.

5. Each valve shall have metering ports incorporating Nordel check valves on both sides of the seat.

6. All valves shall be “Y” pattern, equal percentage, globe style, designed either for presetting with a balance schedule or for proportional balancing. All metal parts are bronze copper alloy. Each valve shall provide four functions:

a. precise flow measurement;

b. precision flow balancing;

c. positive shutoff with a no-drip soft seat; and

d. diagnostic point for system analysis.

7. A ¼” NPT tapped drain port shall be provided on each side of valve seat.

8. Valves shall have four (4) full 360 degree adjustment turns of the handwheel (1,440 degrees) with a micrometer-type indicator and hidden memory feature to program the valve for a precise, tamper-proof, balanced setting. When installed, the handwheel and metering ports shall not be located on the bottom of the valve to prevent sediment deposits. Handwheel scale must be able to be positioned so that it may be clearly read without the use of mirrors or any special tools. Metering ports shall be interchangeable with drain ports to allow for read-out flexibility when installed in tight piping locations.

9. Each threaded CBV-T to be shipped with a pre-formed insulation to meet or exceed ASTM D1784/Class 14253-C, MEA #7-87, ASTM E84, and ASTM E136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

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

   a. Armstrong Pumps, Inc.

   b. Tour & Andersson; available through Victaulic Company of America.

   c. Macon

   d. Mepco.

2. CWP Rating: Minimum 125 psig.

3. Maximum Operating Temperature: 250 deg F.

4. CBV-G 2½” through 12” Flanged:

5. Furnish and install, as shown on plans and with manufacturer’s recommendations, Circuit Balancing Valves.

6. The valve body shall be ductile iron with grooved ends or with Armgrip(tm) non-rotating ductile iron flange adapters. Valves shall be suitable for the working pressures and temperatures as shown on drawings.

7. Each valve shall have metering ports incorporating Nordel check valves, on both sides of the seat.

8. All valves shall be “Y” pattern, modified equal percentage, globe style, designed either for presetting with a balance schedule or for proportional balancing. Each valve shall perform four functions:

   a. precise flow measurement

   b. precision flow balancing

   c. positive shutoff with a no-drip soft seat; and

   d. diagnostic point for system analysis.

9. Valves shall have five, (2½" and 3") six, (4" through 6") twelve, (8") ten, (10") or fourteen (12") full 360 degree adjustment turns of the handwheel with a micrometer-type indicator and hidden memory feature to program the valve for a precise, tamper-proof balanced setting. When installed, the handwheel and metering ports shall not be located on the bottom of the valve to prevent sediment deposits. Handwheel scale must be able to be positioned so that it may clearly read without the use of mirrors or any special tools.

10. Circuit balancing valves shall be installed at least five pipe diameters downstream from any fitting and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream of the CBV shall be free of any fitting.

11. The valve shall be furnished with pre-formed insulation to meet or exceed ASTM D1784/Class 14253-C, MEA #7-87, ASTM E84, and ASTM E136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less.

E. Diaphragm-Operated, Pressure-Reducing Valves:

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

   a. Amtrol, Inc.

   b. Armstrong Pumps, Inc.

   c. Bell & Gossett Domestic Pump; a division of ITT Industries.

   d. Conbraco Industries, Inc.

   e. Spence Engineering Company, Inc.

   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.

5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.

7. Low inlet-pressure check valve.

8. Inlet Strainer: S.S. screen, removable without system shutdown.

9. Valve Seat and Stem: Noncorrosive.

10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

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

a. Amtrol, Inc.

b. Armstrong Pumps, Inc.

c. Bell & Gossett Domestic Pump; a division of ITT Industries.

d. Conbraco Industries, Inc.

e. Spence Engineering Company, Inc.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.

5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.

7. Wetted, Internal Work Parts: Brass and rubber.

8. Inlet Strainer: S.S. screen, removable without system shutdown.

9. Valve Seat and Stem: Noncorrosive.

10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.7 AIR CONTROL DEVICES

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

1. Amtrol, Inc.

2. Armstrong Pumps, Inc.

3. Bell & Gossett Domestic Pump; a division of ITT Industries.

4. Taco.

5. John Woods (for air separators and expansion tanks).

B. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.

3. Operator: Screwdriver or thumbscrew.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/8.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.

2. Internal Parts: Nonferrous.

3. Operator: Noncorrosive metal float.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/4.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 240 deg F.

D. Diaphragm-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.

2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.

3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.

4. Blowdown Connection: Threaded.

5. Size: Match system flow capacity.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

B. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

3. Performance: Capable of misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

C. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

2.9 THERMOMETERS

A. Provide thermometers where indicated, specified, and required. They shall be installed so that they can be clearly read from the floor.

B. Industrial stem thermometers shall have a scale not less than 9" long and shall be red-reading mercury type with white background and black etched graduations and numerals. Casing materials shall be aluminum on all products installed outdoors.

C. Thermometers shall be suitable for the service intended and the range shall be selected to span from approximately 10 degrees below through 10 degrees above the operating range of the fluid.

D. Thermometers shall have a guaranteed accuracy of within 1% of the range scale and shall be provided with 1 degree graduations. Thermometers shall be provided with brass separable socket wells.

E. Provide thermometer wells and necessary fittings where specified or indicated. Wells installed in insulated piping shall be provided with lagging extensions of appropriate length to accommodate insulation.

F. Thermometers shall be as manufactured by Marsh Instrument Co., Weksler Instrumentation, Trerice, Miljoco, or approved equal.

2.10 PRESSURE GAUGES

A. Pressure and compound pressure gauges shall be installed so that they can be clearly read from the floor and shall be Bronze Bourdon tube type with minimum 6" dials and snubbers. Dials shall be white with black numerals, graduations, and pointers, and shall be set in either iron, steel, or aluminum cases having a baked enamel finish. Cases shall have safety blowout plugs.

B. Pressure gauges shall have a range of approximately twice the operating pressure and all gauges shall have an accuracy of 1/2 of 1% of full scale reading. Gauges shall be provided with brass shutoff cocks.

C. Provide compound pressure gauges in pump suction pipe (30" Hg VAC. to 100 psi).

D. Provide gauges where indicated, specified, or required.

E. Gauges shall be manufactured by Marshalltown Instrument, Weksler Instrumentation, Trerice, Miljoco, or approved equal.

2.11 P/T PLUGS

A. Provide, in locations shown on drawings, a 1/2 inch MPT fitting for pipe line and 1/4 inch for valve body locations to receive either a temperature or pressure probe 1/8 inch OD. Fitting shall be solid brass with two valve cores of Neoprene capable of withstanding a maximum temperature of 200 deg. F at 500 psi, fitted with a color coded and marked cap with gasket, and shall be rated at 1000 psig at 140 deg. F.

B. Provide Owner with pressure gauge adapters with 1/8" O.D. probe and 5 inch testing thermometers for chilled water with a 25 - 125 F range.

C. Supply and present to the Owner upon completion of testing, two (2) pressure and temperature test kits. Each shall consist of one dual scale (0-100 psi, 0-230 feet of water) pressure gauge with a No. 500 gauge adapter attached, one 25-125 F pocket testing thermometer, one 0-220 F pocket testing thermometer, one 500 gauge adapter, and one protective carrying case.

D. Acceptable manufacturers shall be Peterson, Sisco, or approved equal.

2.12 SUCTION DIFFUSER

A. Provide a suction diffuser at inlet of each base mounted pump. Unit shall consist of angle type body with inlet vanes and combination Diffuser-Strainer-Orifice cylinder with 3/16" diameter openings for pump protection. Unit shall be equipped with disposable fine mesh start-up strainer which shall be removed after thirty (30) days of operation. Strainer free area shall be no less than five (5) times the section area of the pump connection. Unit shall be provided with adjustable support foot to carry weight of suction piping.

B. Suction diffusers shall be as manufactured by Bell and Gossett, TACO, Armstrong, Titan FCI, Mueller, **or American Wheatly**.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping and chilled water piping, aboveground, NPS 2 and smaller shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

2. Schedule 40 steel pipe; Class 150 or Class 300 Malleable Iron fittings; and threaded joints.

B. Hot-water heating piping, and chilled water piping aboveground, NPS 2-1/2 and larger shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Condenser-water piping, aboveground, NPS 2 and smaller shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

2. Schedule 40 steel pipe; Class 150 or Class 300 Malleable Iron fittings; and threaded joints.

D. Condenser-water piping, aboveground, NPS 2-1/2 and larger shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Makeup-water piping installed aboveground shall be the following:

1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

1. Condensate-Drain Piping: Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

H. Air-Vent Piping:

1. Inlet: Same materials and joining methods as for piping specified for the service in which air-vent is installed.

I. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves where indicated on the drawings.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and 3/4 inch hose connection with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Provide strainer blowdown valve with 3/4 inch hose connection with cap.

S. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS ¾ to NPS 1-1/4: Maximum span, 6.5 feet; minimum rod size, 3/8 inch.

2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inc).

3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

4. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

5. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

6. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.

7. NPS 6: Maximum span, 10 feet; minimum rod size, 5/8 inch.

8. NPS 8: Maximum span, 14 feet; minimum rod size, 7/8 inch.

9. NPS 100: Maximum span, 14 feet; minimum rod size, 7/8 inch.

10. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.

11. NPS 14: Maximum span, 20 feet; minimum rod size, 1 inch.

12. NPS 16: Maximum span, 20 feet; minimum rod size, 1 inch.

13. NPS 18: Maximum span, 20 feet; minimum rod size, 1-1/4 inches.

14. NPS 20: Maximum span, 20 feet; minimum rod size, 1-1/4 inches.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.

2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.

3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger. Install automatic air vents at top of air separator. Refer to detail on drawings for further information..

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position. Install feeder in minimum NPS 3/4insulated bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install expansion tanks on the minimum 4”pad housekeeping. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements. Refer to details.

G. Flow switches, temperature sensors, sensor sockets, wells gage taps, etc. shall be furnished under controls section of these specifications and installed under this Section. Locations of all sensor sockets, flow switches, and taps shall be coordinated with and supervised by the Controls Contractor.

H. Motorized control valves shall be furnished by the Controls Contractor, installed by the Mechanical Contractor.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Provide P/T ports at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping." Refer to details.

E. Install thermowells and ports for pressure gages and thermometers at equipment as indicated on details and according to Division 23 Section "Meters and Gages for HVAC Piping." Refer to details.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

3.9 UNDERGROUND PIPE INSTALLATION

A. General

1. Installation of exterior buried factory-prefabricated preinsulated chilled water piping systems shall be in accordance with manufacturer's installation manual. Welding of steel piping including qualification of welders shall be in accordance with ASME B31.I, metallic arc process. Install piping straight and true to bear evenly on sand bedding material.

2. Installation Drawings: The system supplier shall provide engineered drawings of the piping layout indicating anchor locations and provisions for expansion and/or contraction. Computerized stress calculations including anchor forces shall be provided by the system manufacturer upon receipt from the installing contractor approved drawings complete with field measured dimensions. Drawing shall be signed and sealed by a P.E. employed by the piping manufacturer.

3. All units shall be part-numbered and dimensionalized for proper installation of the system.

4. Insulate and jacket field joints as indicated on the drawings.

5. Pipe handling: Pipe and accessories shall be handled in a manner to ensure delivery to the trench in an undamaged condition. Particular care shall be taken not to injure the pipe jacket and insulation. If any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in an approved manner. The interior of pipe and accessories shall be cleaned before being lowered into the trench for welding connection operations.

6. Cleaning of Piping: Keep interior and ends of new piping and existing piping affected by the Contractor's operations, cleaned of water and foreign matter during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

7. Demolition: Remove materials so as not to damage materials which are to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

B. Field Joints

1. Carrier Piping Joints Without Concrete Anchor: Pressure test and approve piping joints. Provide joints with polyurethane insulation of same type and thickness as insulation on carrier piping. Provide waterproof shrink sleeves to cover insulation and overlap not less than 6 inches of each end of conduit section. Seal joint jacket watertight to adjacent jacketing to withstand 20 feet of hydrostatic water pressure.

2. Carrier Piping Joints With Concrete Anchor: Pressure test and approve piping joints. Provide each tee with concrete anchors (thrust blocks). Provide waterproof end seals between carrier piping and conduit. Encase carrier pipe fitting and conduit with a minimum of 6 inches of concrete or as otherwise shown in details or per manufacturer's calculations.

C. Assembly and Alignment: Assemble carrier pipe and fittings according to manufacturer's installation manual. Maintain proper alignment during assembly of welded joints and flanged joints.

D. Bedding: Accurately grade trench bedding with a minimum of 6 inches of manufactured or natural sand. Backfill sand to a minimum of 4 inches below conduit. Lay bedding to firmly support conduit along entire length.

E. Concrete: Thrust Blocks: Encase each tee of carrier pipe in thrust block against undisturbed soil. Disturbed soil under and around thrust blocks shall be compacted. Pour concrete anchor blocks where shown on installation drawings. After all anchor blocks are poured and cured, a hydrostatic test of shall be required as specified under Section 15990. No leakages shall be allowed.

F. Field Quality Control

1. Before final acceptance of work, test each system to demonstrate compliance with contract requirements. Thoroughly flush and clean piping before placing in operation. Flush piping at minimum velocity of 8 fps. Correct defects in the work and repeat tests until work is in compliance with contract requirements. Furnish potable water, electricity, instruments, connecting devices, and personnel for tests.

2. The services of a factory trained field service instructor directly employed by the system manufacturer (factory certified sales agent or representative) shall be required during the installation (once at the beginning for instructing the Contractor, once at the midpoint, and once at the end point of the project) and on-site to witness each hydronic test. The Instructor must obtain a daily written report from the Installation Contractor identifying progress and potential conflicts. The written report shall be presented to the Instructor on the same day it is prepared, one copy shall be forwarded to manufacturer's office, and one copy shall be forwarded to the Engineer’s office.

   The Instructor shall prepare site inspection reports which shall state whether or not the condition and quality of materials used and the installation of the system are in accordance with the manufacturer's approved drawing and published literature and is satisfactory in all respects, each time the instructor visits the site. A final report shall be signed by an officer of the manufacturer and duly notarized certifying the materials are installed in accordance with the manufacturers requirements and recommendations and will satisfactorily serve the intended use, including maintaining an insulation barrier between the pipe and surrounding soil, for the anticipated service life of the pipe.

3. Immediately after the system is installed in the ditch, a partial backfill shall be made in the middle of each unit leaving the joints exposed for inspection prior to the hydrostatic tests. The initial backfill is to be 12" of select materials, hand tamped in 6" layers above the jacket. Do not use frozen fill, sod, cinders or stones greater than 1/4" as backfill.

4. Field Tests of Carrier Piping: Do not cover carrier piping joints with insulation or concrete anchors (thrust blocks), until carrier piping joints pass field tests.

5. Hydrostatic Pressure Test: Test piping system in accordance with the requirements herein. Refer to the Field Quality Control Section below. During hydrostatic pressure test, examine piping system for leaks. Repair leaking joints, replace damaged and porous pipe and fittings with new materials, and repeat tests. The piping shall be tested in sections as required by the Contracting Officer to coordinate with disruption of utilities and traffic patterns. Contractor shall provide the necessary flanges, blank-off plates and valves for sectionalized testing.

6. After hydrostatic testing, backfill all remaining exposed pipe as instructed. Final backfill of selected earth shall be hand-placed and tamped in 12" layers over the top of the initial backfill. Remainder of the backfill shall be free of large boulders, rocks over 6" in diameter, frozen earth, or foreign matter. The backfill operation shall now be completed by any convenient means. Do not use wheeled or tracked vehicles for tamping.

7. Thrust Blocks: Place bedding and backfill around center portion of piping system, leaving thrust blocks and field joints clear for observation. After successful completion of hydrostatic pressure test, cast concrete thrust blocks.

8. Field Inspections: Prior to initial operation, inspect piping system for compliance with drawings, specifications, and manufacturer's submittals.

3.10 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.11 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure (125 psi) . Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

3.12 CLEANING SEQUENCE

A. Hydronic Water Systems: Contractor shall rent a pump with strainer and pipe to new system. Contractor shall circulate for 48 hours, then drain systems as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed. After cleaning and flushing, the Contractor shall connect new piping to existing system as shown on drawings. Chemical Water treatment to be provided immediately upon acceptance of the cleaning.

B. The piping shall be thoroughly flushed with cleaned throughout with clean potable water at a rate of 6 to 8 feet per minute through the largest pipe on the circuit but not exceeding a pressure of 100 psi in the piping system. Provide a temporary bypass on the boiler piping to allow full circulation throughout the existing piping system including as much of the new piping system as possible minus the boilers and pumps. The temporary connection of the supply and return pipe at boiler bypass shall facilitate the flow of water through the piping system during flushing. Flush each heating branch and main system for a minimum of two hours and until the flushing water exiting the piping is clear and free of debris as determined by the owner's chemical treatment company. The source of the water supply to be used for flushing shall be as approved by the authority having jurisdiction. The contractor shall provide the temporary pumping system to be used for flushing the piping system. The new boiler pumps shall not be used as the flushing pumps. The flushing pumps shall be of the capacity (flow rate and dynamic head) as necessary to motivate the water through the largest pipe in the system at a minimum 6 fpm velocity. Provide temporary flexible piping and connections to the system as necessary to and from the flushing pumps.

C. Provide all necessary utility connections to the flushing pumps including power, make-up water, drain piping, etc. as necessary for safe operation. If diesel driven flushing pumps are used, these pumps shall be located outdoors in the appropriate open air environment far enough away from the building intake openings such that the diesel exhaust fumes do not pose any threats or perceived threats to the safety of the building environment and building occupants.

D. Prior the flushing and cleaning, this contractor shall remove, clean and reinstall all strainers on the heating system in the building. Upon completion of the flushing and cleaning process, this contractor shall again remove, clean and reinstall all strainers, and fill system with clean water. Adjust the expansion tank for pressure proper operation.

E. Once the system has been flushed, add cleaner to closed systems at concentration as recommended by manufacturer of water contained in the system; of one pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.

F. Each piping system shall be thoroughly cleaned by filling with a solution of commercial cleaning chemicals designed to remove deposits such as pipe dope, oils, loose mill scale, rust and other extraneous materials. The recommended dosages and characteristics of the cleaner shall be such that the water need only be at ambient temperature. After the recommended dosages are added, the water shall be circulated for 36-72 hours. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Systems shall then be drained, filled and flushed with clean water until no foreign matter is observed and total alkalinity of rinse water is equal to that of the make up water.

G. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.

H. Flush systems with clean water for one hour minimum. Drain completely and refill.

I. Remove, clean, and replace strainer screens.

J. Each system shall be properly treated to prevent scaling and corrosion.

K. The water treatment service company currently under contract with the owner shall provide the flushing, cleaning and chemical treatment process.

L. All cost associated with this service and certification shall be paid by the Contractor as a basic part of this project.

*** END OF SECTION 23 21 13 ***

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Bypass chemical-feed equipment and controls.
2. Biocide chemical-feed equipment and controls.
3. Chemical treatment test equipment.
4. HVAC water-treatment chemicals.
5. Makeup water softeners.
6. Water filtration units for HVAC makeup water.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including [hot-water heating] [chilled water] [dual-temperature water] [and] [glycol cooling], shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.

2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.

3. Boron: Maintain a value within 100 to 200 ppm.

4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.

5. Soluble Copper: Maintain a maximum value of 0.20 ppm.

6. TDS: Maintain a maximum value of 10 ppm.

7. Ammonia: Maintain a maximum value of 20 ppm.

8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.

9. Microbiological Limits:

   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

   b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.

   c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.

   d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.

   e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

D. Open hydronic systems, including condenser water, shall have the following water qualities:

1. pH: Maintain a value within 8.0 to 9.1.

2. "P" Alkalinity: Maintain a maximum value of 100 ppm.

3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.

4. Soluble Copper: Maintain a maximum value of 0.20 ppm.

5. TDS: Maintain a maximum value of 10 ppm.

6. Ammonia: Maintain a maximum value of 20 ppm.

7. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm

8. Microbiological Limits:

   a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.

b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.

d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.

e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

9. Polymer Testable: Maintain a minimum value within 10 to 40.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Bypass feeders.

2. Water meters.

3. Inhibitor injection timers.

4. pH controllers.

5. TDS controllers.

6. Biocide feeder timers.

7. Chemical solution tanks.

8. Injection pumps.

9. Ozone generators.

10. UV-irradiation units.

11. Chemical test equipment.

12. Chemical material safety data sheets.

13. Water softeners.

14. RO units.

15. Multimedia filters.

16. Self-cleaning strainers.

17. Bag- or cartridge-type filters.

18. Centrifugal separators.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

E. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.

2. Water Analysis: Illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

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

1.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, heating, hot-water piping piping, condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.

2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.

3. Periodic field service and consultation.

4. Customer report charts and log sheets.

5. Laboratory technical analysis.

6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design—NALCO.

B. Other Substitutes—Submit a written substitution request, prior to bid, to the Architect/Engineer in accordance with Specification Section 23 05 00. Accepted substitutes will be notified via Addendum.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel. Provide feeders with side stream 5 micron bag filter with a minimum of 2 spare replacement bags. Rotate a clean bag into service each month. Clean and dry removed bag for use in rotation. Continue rotation for first 6 month or until owners water treatment contractor takes over maintenance. Insulate inlet and outlet piping from system piping to feeders. Provide inlet and outlet shut-off valves and calibrated balance valve. Refer to detail on drawings.

1. Capacity: 5 gal.

2. Minimum Working Pressure: 175 psig.

2.3 AUTOMATIC CHEMICAL FEED EQUIPMENT

A. Water Meter:

1. AWWA C701, turbine-type, totalization meter.

2. Body: Bronze.

3. Minimum Working-Pressure Rating: 100 psi.

4. Maximum Pressure Loss at Design Flow: 3 psig.

5. Registration: Gallons or cubic feet.

6. End Connections: Threaded.

7. Control: Low-voltage signal capable of transmitting 1,000 feet.

B. Inhibitor Injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."

2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.

3. Test switch.

4. Hand-off-auto switch for chemical pump.

5. Illuminated legend to indicate feed when pump is activated.

6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.

7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."

2. Digital display and touch pad for input.

3. Sensor probe adaptable to sample stream manifold.

4. High, low, and normal pH indication.

5. High or low pH alarm light, trip points field adjustable; with silence switch.

6. Hand-off-auto switch for acid pump.

7. Internal adjustable hysteresis or deadband.

D. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door

2. Digital display and touch pad for input.

3. Sensor probe adaptable to sample stream manifold.

4. High, low, and normal conductance indication.

5. High or low conductance alarm light, trip points field adjustable; with silence switch.

6. Hand-off-auto switch for solenoid bleed-off valve.

7. Bleed-off valve activated indication.

8. Internal adjustable hysteresis or deadband.

9. Bleed Valves:

   a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.

E. Biocide Feeder Timer:

1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.

2. 24-hour timer with 14-day skip feature to permit activation any hour of day.

3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.

4. Solid-state alternator to enable use of two different formulations.

5. 24-hour display of time of day.

6. 14-day display of day of week.

7. Battery backup so clock is not disturbed by power outages.

8. Hand-off-auto switches for biocide pumps.

9. Biocide A and Biocide B pump running indication.

F. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.

2. Molded cover with recess for mounting pump.

3. Capacity: 30 gal.

G. Chemical Solution Injection Pumps:

1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.

2. Adjustable flow rate.

3. Metal and thermoplastic construction.

4. Built-in relief valve.

5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

I. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.

2. Ball Valve: Three or two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.

3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.

4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.4 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

D. Controls: Interlock with pumps to operate when water is circulating.

2.5 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.

2. Four-station rack for open systems.

2.6 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

B. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.

2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

PART 3 EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

2. Install water meter in makeup water supply.

3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.

5. Install a swing check on inlet after the isolation valve.

F. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:

1. Install makeup water softener.

2. Install water meter in makeup water supply.

3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

a. Pumps shall operate for timed interval when contacts close at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and furnish test-kit to Owner.

5. Install TDS controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum TDS concentration.

G. Install automatic chemical-feed equipment for condenser water and include the following:

1. Install makeup water softener.

2. Install water meter in makeup water supply.

3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

5. Install TDS controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum TDS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH.

7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

    a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."

E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

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

B. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.

2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.

3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.

4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

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

D. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. For one year, sample boiler water at six week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

E. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.

2. Steam System: ASTM D 1066.

3. Acidity and Alkalinity: ASTM D 1067.

4. Iron: ASTM D 1068.

5. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

*** END OF SECTION 23 25 00 ***

SECTION 23 29 23

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for monitoring and control of motor circuits.

2. Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.3 DEFINITIONS

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFC: Variable frequency controller.

1.4 SUBMITTALS

A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFC.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.

b. Nameplate legends.

c. Short-circuit current rating of integrated unit.

d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.

e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that VFCs, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For manufacturer.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFCs and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InternNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

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

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40 deg C.

2. Humidity: Less than 90 percent (noncondensing).

3. Altitude: Not exceeding 3300 feet.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than twodays in advance of proposed interruption of electrical service.

2. Indicate method of providing temporary electrical service.

3. Do not proceed with interruption of electrical service without Owner's written permission.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.8 COORDINATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

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

1. Basis of Design:

a. ASEA Brown Boveri (ABB).

2. Pre-Approved Substitutes:

a. Trane.

b. Square D.

c. Toshiba International Corporation.

d. Weg.

e. Yeskawa.

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

B. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

C. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Unit Operating Requirements:

1. Input ac voltage tolerance of plus or minus 10 percent.

2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.

3. Minimum Efficiency: 96 percent at 60 Hz, full load.

4. Minimum Displacement Primary-Side Power Factor: 96 percent.

5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.

6. Starting Torque: 100 percent of rated torque or as indicated.

7. Speed Regulation: Plus or minus 1 percent.

F. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

G. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.

2. Maximum Speed: 80 to 100 percent of maximum rpm.

3. Acceleration: 2 to a minimum of 22 seconds.

4. Deceleration: 2 to a minimum of 22 seconds.

5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

H. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.

2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.

3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class [10] [20] [30] performance.

4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.

5. Instantaneous line-to-line and line-to-ground overcurrent trips.

6. Loss-of-phase protection.

7. Reverse-phase protection.

8. Short-circuit protection.

9. Motor overtemperature fault.

I. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

J. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Input Line Conditioning: 3%.

O. VFC Output Filtering: 3%.

P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.

2. Run.

3. Overvoltage.

4. Line fault.

5. Overcurrent.

6. External fault.

Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).

2. Motor speed (rpm).

3. Motor status (running, stop, fault).

4. Motor current (amperes).

5. Motor torque (percent).

6. Fault or alarming status (code).

7. PID feedback signal (percent).

8. DC-link voltage (VDC).

9. Set-point frequency (Hz).

10. Motor output voltage (V).

S. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

a. 0 to 10-V dc.

b. 0-20 or 4-20 mA.

c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs.

e. RS485.

f. Keypad display for local hand operation.

3. Output Signal Interface:

a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

1) Output frequency (Hz).

2) Output current (load).

3) DC-link voltage (VDC).

4) Motor torque (percent).

5) Motor speed (rpm).

6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.

b. Set-point speed reached.

c. Fault and warning indication (overtemperature or overcurrent).

d. PID high- or low-speed limits reached.

T. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

U. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

V. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

W. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

X. Isolating Switch: Non-load-break switch arranged to isolate VFC and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

Y. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ENCLOSURES

A. NEMA 1.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:

1. Output frequency (Hz).

2. Set-point frequency (Hz).

3. Motor current (amperes).

4. DC-link voltage (VDC).

5. Motor torque (percent).

6. Motor speed (rpm).

7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.

2. Running log of total power versus time.

3. Total run time.

4. Fault log, maintaining last four faults with time and date stamp for each.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Install VFCs on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Common Work Results for Electrical," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Assist in field testing of equipment[including pretesting and adjusting of solid-state controllers.

3. Report results in writing.

C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

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

F. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.

1 Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training."

*** END OF SECTION 23 29 23 ***

SECTION 23 31 13

METAL DUCTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round and flat-oval ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.

2. Sealants and gaskets.

3. Seismic-restraint devices.

B. LEED Submittals:

1. Product Data for Prerequisite EQ1: Documentation indicating that duct systems comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

2. Product Data for Prerequisite EA2: Documentation indicating that duct systems comply with ASHRAE/IESNA90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

3. Leakage Test Report for Prerequisite EA2: Documentation of work performed for compliance with ASHRAE/IESNA90.1-2004, Section 6.4.4.2.2 - "Duct Leakage Tests."

4. Duct-Cleaning Test Report for Prerequisite EQ1: Documentation of work performed for compliance with ASHRAE 62.1-2004, Section 7.2.4 - "Ventilation System Start-Up."

5. Product Data for Credit EQ4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

2. Factory- and shop-fabricated ducts and fittings.

3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of top of ducts.

5. Dimensions of main duct runs from building grid lines.

6. Fittings.

7. Reinforcement and spacing.

8. Seam and joint construction.

9. Penetrations through fire-rated and other partitions.

10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.

2. Joint and seam construction and sealing.

3. Reinforcement details and spacing.

4. Materials, fabrication, assembly, and spacing of hangers and supports.

E. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.

3. Structural members to which duct will be attached.

4. Size and location of initial access modules for acoustical tile.

5. Penetrations of smoke barriers and fire-rated construction.

6. Items penetrating finished ceiling including the following:

a. Lighting fixtures.

b. Air outlets and inlets.

c. Speakers.

d. Sprinklers.

e. Access panels.

f. Perimeter moldings.

F. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

1.6 DEFINITIONS

A. A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. B. Low Pressure: Three pressure classifications:

1. 1/2 inch WG positive or negative static pressure and velocities less than 2,000 fpm;

2. 1 inch WG positive or negative static pressure and velocities less than 2,500 fpm; and

3. 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm.

C. Medium Pressure: Two pressure classifications:

1. 3 inch WG positive or negative static pressure and velocities less than 4,000 fpm; and

2. 4 inch WG positive static pressure and velocities less than 4,000 fpm.

PART 2 PRODUCTS

2.1 SINGLE-WALL RECTANGUL AR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGUL AR DUCTS AND FITTINGS

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

1. McGill AirFlow LLC.

2. Sheet Metal Connectors, Inc.

3. Metal Mart

4. Express Metals.

5. Eastern Sheet Metal

6. Commercial Duct Systems

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMAAH124, "Fibrous Glass Duct Liner Standard."

1. Insulation shall be fiberglass that is 1” thick acoustical duct liner rated for 6,000 fpm air velocity, 250 °F maximum operating temperature, and shall be applied to the inner surface of the outer shell using duct liner adhesive.

2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x degF at 75 degF mean temperature. Installed duct shall have a minimum R-4.2 Thermal Insulation Rating.

3. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.

4. Insulation shall meet antimicrobial resistant requirements.

5. Cover insulation with polyester film complying with UL 181, Class 1.

G. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch diameter perforations, with overall open area of 23 percent.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

J. Provide access doors on supply and return; 6-8 feet from the unit; minimum size 18”x18” and at 10 foot intervals to the end of the 40 foot length.

K. Ductwork Shop Drawings/Field Coordination: All double wall ductwork shall be factory premanufactured (fittings and straight lengths). As a basic part of this manufacturer’s contractual requirements, they shall provide a minimum ¼" per foot, scaled, coordinated, ductwork shop drawings (coordination drawings). The coordination drawings shall be field verified by a certified manufacturer’s representative and the installing contractor(s). The coordination drawings shall represent the actual routing, mounting locations, transitions, etc., as necessary to achieve the design intent while optimizing the use of the designated installation space as it relates to equipment and materials of other trades in that space (i.e., piping, air handlers, starters, building structure, electrical panels, etc). These coordination drawings shall be submitted to the Engineer for review and approval prior to ordering materials. These coordination drawings shall be submitted to the Engineer no later than four (4) weeks after the contract between Owner and Contractor is signed.

L. Provide double-wall duct for the first 40 feet of the supply and return ductwork from the air handler.

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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

a. Lindab Inc.

b. McGill AirFlow LLC.

c. SEMCO Incorporated.

d. Sheet Metal Connectors, Inc.

e. Spiral Manufacturing Co., Inc.

f. Commercial Duct Systems.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

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

1. Lindab Inc.

2. McGill AirFlow LLC.

3. SEMCO Incorporated.

4. Sheet Metal Connectors, Inc.

5. Eastern Sheet Metal

6. Commercial Duct Systems

G. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

H. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Ductwork Shop Drawings/Field Coordination: All double wall ductwork shall be factory premanufactured (fittings and straight lengths). As a basic part of this manufacturer's contractual requirements, they shall provide a minimum ¼" per foot, scaled, coordinated, ductwork shop drawings (coordination drawings). The coordination drawings shall be field verified by a certified manufacturer's representative and the installing contractor(s). The coordination drawings shall represent the actual routing, mounting locations, transitions, etc., as necessary to achieve the design intent while optimizing the use of the designated installation space as it relates to equipment and materials of other trades in that space (i.e., piping, air handlers, starters, building structure, electrical panels, etc). These coordination drawings shall be submitted to the Engineer for review and approval prior to ordering materials. These coordination drawings shall be submitted to the Engineer no later than four (4) weeks after the contract between Owner and Contractor is signed.

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: Interior Ductwork:G60 (Z180); Exterior Ductwork: G90 (Z275).

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No.2B, No.2D, No.3, or No.4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMAAH124, "Fibrous Glass Duct Liner Standard."

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

a. CertainTeed Corporation; Insulation Group.

b. Johns Manville.

c. Knauf Insulation.

d. Owens Corning.

e. Maximum Thermal Conductivity:

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x degF at 75 degF mean temperature.

2) Type II, Rigid: [0.23 Btu x in./h x sq. ft. x degF] at 75 degF mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

    a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40CFR59, SubpartD (EPA Method24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

3. Butt transverse joints without gaps, and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.

6. Apply adhesive coating on longitudinal seams in ducts.

7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.

    b. Intervals of lined duct preceding unlined duct.

    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.

3. ShoreA Hardness: Minimum 20.

4. Water resistant.

5. Mold and mildew resistant.

6. VOC: Maximum 75g/L (less water).

7. Maximum Static-Pressure Class : 10-inch wg, positive and negative.

8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Base: Synthetic rubber resin.

3. Solvent: Toluene and heptane.

4. Solids Content: Minimum 60 percent.

5. ShoreA Hardness: Minimum 60.

6. Water resistant.

7. Mold and mildew resistant.

8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40CFR59, SubpartD (EPA Method24).

9. VOC: Maximum 395g/L.

10. Maximum Static-Pressure Class : 10-inch wg, positive or negative.

11. Service: Indoor or outdoor.

12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.

2. Type : S.

3. Grade: NS.

4. Class : 25.

5. Use: O.

6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40CFR59, SubpartD (EPA Method24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Provide a minimum ¼" per foot, scaled, coordinated, ductwork shop drawings (coordination drawings). The coordination drawings shall represent the actual routing, mounting locations, transitions, etc., as necessary to achieve the design intent while optimizing the use of the designated installation space as it relates to equipment and materials of other trades in that space (i.e., piping, air handlers, starters, building structure, electrical panels, etc). These coordination drawings shall be submitted to the Engineer for review and approval prior to ordering materials. These coordination drawings shall be submitted to the Engineer no later than four (4) weeks after the contract between Owner and Contractor is signed.

B. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

D. Install round and flat-oval ducts in maximum practical lengths.

E. Install ducts with fewest possible joints.

F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

K. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

L. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No.3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Outdoor, Supply-Air Ducts: Seal Class A.

3. Outdoor, Exhaust Ducts: Seal Class A.

4. Outdoor, Return-Air Ducts: Seal Class A.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.

6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.

7. Unconditioned Space, Exhaust Ducts: Seal Class A.

8. Unconditioned Space, Return-Air Ducts: Seal Class A.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.

10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.

11. Conditioned Space, Exhaust Ducts: Seal Class A.

12. Conditioned Space, Return-Air Ducts: Seal Class A.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

B. Paint exposed ductwork in occupied areas with no ceilings, including, but not limited to, gym courts, gym corridors, weight rooms, art rooms, etc.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems:

a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

b. Ducts with a Pressure Class of 2-Inch wg: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean existing duct system(s) intended to be reused before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDUL E

A. VAV Supply Ductwork (High Side): 2 inch WG positive static pressure and velocities less than 2,500 fpm. Test duct leakage in accordance with Seal Class A.

B. All Air Handlers (first 40 feet on supply side of unit connection): 4 inch WG positive static pressure and velocities less than 4,000 fpm. Test duct leakage in accordance with Seal Class A.

C. All Air Handlers (first 40 feet on return side of unit connection): 3 inch WG negative static pressure and velocities less than 4,000 fpm. Test duct leakage in accordance with Seal Class A.

D. VAV Distribution Ductwork (low side): 1 inch positive static pressure and velocities less than 2,500 fpm. Seal ductwork in accordance with Seal Class A. Testing may not be required if deemed acceptable by the Engineer during construction. Test duct leakage in accordance with Seal Class C.

E. Return Ductwork: 1 inch negative static pressure and velocities less than 2,500 fpm. Seal ductwork in accordance with Seal Class A. Testing may not be required if deemed acceptable by the Engineer during construction. Test duct leakage in accordance with Seal Class C.

F. Exhaust Ductwork and Outside Air Ductwork: 1 inch positive or negative static pressure and velocities less than 2,500 fpm. Seal ductwork in accordance with Seal Class A. Testing may not be required if deemed acceptable by the Engineer during construction. Test duct leakage in accordance with Seal Class C.

G. Transfer Ductwork: 1/2 inch positive or negative static pressure and velocities less than 2,000 fpm. Seal ductwork in accordance with Seal Class A. Testing may not be required if deemed acceptable by the Engineer during construction. Test duct leakage in accordance with Seal Class C.

H. Fabricate ducts as follows:

AIR SYSTEM	MATERIAL
Low Pressure Supply	Galvanized Steel
Medium Pressure Supply	Galvanized Steel
Return and Relief	Galvanized Steel
General Exhaust	Galvanized Steel
Outside Air Intake	Galvanized Steel

I. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class : Positive 1-inch wg.

   b. Minimum SMACNA Seal Class : A.

   c. SMACNA Leakage Class for Rectangular: 24.

   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units for the first forty (40) feet:

   a. Pressure Class : Positive 4-inch wg.

   b. Minimum SMACNA Seal Class : A.

   c. SMACNA Leakage Class for Rectangular: 6.

   d. SMACNA Leakage Class for Round and Flat Oval: 3.

3. Ducts Connected to Air-Handling Units after the first forty (40) feet:

   a. Pressure Class : Positive 2-inch wg.

   b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

4. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class : Positive 2-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

J. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class : Positive or negative 1-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 24.

d. SMACNA Leakage Class for Round and Flat Oval: 12

2. Ducts Connected to Air-Handling Units for the first forty (40) feet:

a. Pressure Class : Positive or negative 3-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Air-Handling Units after the first forty (40) feet:

a. Pressure Class : Positive or negative 2-inch wg (500 Pa).

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

4. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class : Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

K. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE62.1, Class 1 and 2) Air:

a. Pressure Class : Negative 1-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 24.

d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class : Positive or negative 3-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.

b. Concealed: Type 304, stainless-steel sheet, No. 2D finish or Carbon-steel sheet.

c. Pressure Class : Positive or negative 2-inch wg.

d. SMACNA Leakage Class : 3.

4. Ducts Connected to Dishwasher Hoods:

a. Pressure Class : Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class : Welded seams, joints, and penetrations.

c. SMACNA Leakage Class : 3.

5. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:

a. Type 304, stainless-steel sheet.

1) Exposed to View: No.4 finish.

2) Concealed: No.2D finish.

b. Pressure Class : Positive or negative 2-inch wg.

c. SMACNA Leakage Class : 3.

6. Ducts Connected to Fans Exhausting Moist/Wet Air from Gym Shower Rooms:

a. Aluminum metal, unlined duct.

b. Pressure Class : Negative 1-inch wg.

c. Minimum SMACNA Seal Class : A.

d. SMACNA Leakage Class for Rectangular: 24.

e. SMACNA Leakage Class for Round and Flat Oval: 12

7. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class : Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

c. SMACNA Leakage Class for Rectangular: 6.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

L. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Heat Pumps, and Terminal Units:

a. Pressure Class : Positive or negative 1-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class : Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 6.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class : Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class : A.

c. SMACNA Leakage Class for Rectangular: 6.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

M. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: Galvanized.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: Galvanized.

4. Aluminum Ducts: Aluminum.

N. Liner:

1. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch thick.

2. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

O. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1 inch thick.

2. Return Air Ducts: 1 inch thick.

3. Exhaust Air Ducts: [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.

P. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Radius Type RE1 with minimum 1.5 radius-to-diameter ratio.

b. Radius Type RE3 with minimum 1.0 radius-to-diameter ratio and two vanes.

c. Mitered Type RE2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

        1) Radius-to Diameter Ratio: 1.5.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

    c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

Q. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

    a. Rectangular Main to Rectangular Branch: 45-degree entry.

    b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm or Lower: 90-degree tap.

    b. Velocity 1000 to 1500 fpm: Conical tap.

    c. Velocity 1500 fpm or Higher: 45-degree lateral.

*** END OF SECTION 23 31 13 ***

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Stationary Louvers
2. Backdraft and pressure relief dampers.
3. Barometric relief dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Flange connectors.
10. Duct silencers.
11. Turning vanes.
12. Remote damper operators.
13. Duct-mounted access doors.
14. Flexible connectors.
15. Flexible ducts.
16. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittal:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Wiring Diagrams: For power, signal, and control wiring.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.

2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a [No. 2] <Insert finish designation> finish for concealed ducts and <Insert finish designation> finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 STATIONARY LOUVERS

A. Louvers shall bear the AMCA seal and shall have free area and pressure drop ratings certified to be obtained using AMCA standard tests. Ratings shall be based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.

B. Louvers approved by the Miami-Dade County BCCO for use in open structures that have the ability to drain water that may penetrate.

C. Louvers shall have the following construction, unless noted otherwise.

1. Frame:

a. Material: Extruded aluminum, Alloy 6063-T5.

b. Wall Thickness: 0.081 inch, nominal.

c. Depth: 5 inches.

2. Blades:

   a. Style: Sightproof, double drainable, horizontally mounted.

   b. Material: Extruded aluminum, Alloy 6063-T5.

   c. Wall Thickness: 0.081 inch, nominal.

   d. Centers: 2 inches, nominal.

3. Bird Screen:

   a. Material: Aluminum, 5/8 inch x 0.040 inch, expanded, flattened 1/2 inch mesh x 0.063 inch intercrimp.

   b. Frame: Removable, rewireable.

4. Shall be stormproof drainable type.

5. Finish: Kynar finish as selected by the Architect.

6. Mullion: Exposed (used only on louver widths over 71 inches).

D. Each stationary louver covered in this section shall bare the Miami Dade Notice of Acceptance (N.O.A.) seal and be listed by Miami-Dade as having passed each of the following tests. The passage of fewer test standards will not be accepted.

1. TAS-201: Large and Small Missile Impact Test

2. TAS-202: Uniform Structural Load Test

3. TAS-203: Uniform Cyclic Pressure Test

4. Tests shall be based on a minimum 150 mile per hour wind standard.

E. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1-2007.

F. Approved Manufacturers

1. Ruskin.

2. Greenheck.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements:

1. Air Balance Inc.; a division of Mestek, Inc.

2. American Warming and Ventilating; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Duro Dyne Inc.
5. Greenheck Fan Corporation.
6. Lloyd Industries, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. Pottorff; a division of PCI Industries, Inc.
10. Ruskin Company.
11. SEMCO Incorporated.
12. Vent Products Company, Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 1-inch wg.

E. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum 0.050-inch-thick aluminum sheet noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked].

I. Blade Axles:

1. Material: Galvanized steel.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.

4. Chain pulls.

5. Screen Mounting: Front mounted in sleeve.

   a. Sleeve Thickness: 20-gage minimum.

   b. Sleeve Length: 6 inches minimum.

6. Screen Material: Galvanized steel

7. Screen Type: Bird

8. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, Work include, but are not limited to, the following:

   1. Air Balance Inc.; a division of Mestek, Inc.

   2. American Warming and Ventilating; a division of Mestek, Inc.

   3. Cesco Products; a division of Mestek, Inc.

   4. Duro Dyne Inc.

   5. Greenheck Fan Corporation.

   6. Lloyd Industries, Inc.

   7. Nailor Industries Inc.

   8. NCA Manufacturing, Inc.

   9. Pottorff; a division of PCI Industries, Inc.

   10. Ruskin Company.

   11. SEMCO Incorporated.

   12. Vent Products Company, Inc.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: 0.064-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

F. Blades:

1. Multiple, 0.025-inch-thick, roll-formed aluminum.

2. Maximum Width: 6 inches.

3. Action: Parallel.

4. Balance: Gravity.

5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:

1. Material: Galvanized steel.

2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Stainless steel.

L. Accessories:

1. Flange on intake.

2. Adjustment device to permit setting for varying differential static pressures.

2.5 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. Flexmaster U.S.A., Inc.

d. McGill AirFlow LLC.

e. METALAIRE, Inc.

f. Nailor Industries Inc.

g. Pottorff; a division of PCI Industries, Inc.

h. Ruskin Company.

i. Trox USA Inc.

j. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.

b. Mitered and welded corners.

c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.

7. Bearings:

a. Stainless-steel sleeve.

b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. Flexmaster U.S.A., Inc.

d. McGill AirFlow LLC.

e. METALAIRE, Inc.

f. Nailor Industries Inc.

g. Pottorff; a division of PCI Industries, Inc.

h. Ruskin Company.

i. Trox USA Inc.

j. Vent Products Company, Inc.

2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Hat shaped.

b. Galvanized -steel channels, 0.064 inch thick.

c. Mitered and welded corners.

d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Galvanized, roll-formed steel, 0.064 inch thick.

6. Blade Axles: Stainless steel

7. Bearings:

a. Oil-impregnated bronze

b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Blade Seals: Neoprene.

9. Jamb Seals: Cambered stainless steel].

10. Tie Bars and Brackets: Galvanized steel.

11. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Low-Leakage, Aluminum, Manual Volume Dampers:

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

   a. Air Balance Inc.; a division of Mestek, Inc.

   b. American Warming and Ventilating; a division of Mestek, Inc.

   c. Flexmaster U.S.A., Inc.

   d. McGill AirFlow LLC.

   e. METALAIRE, Inc.

   f. Nailor Industries Inc.

   g. Pottorff; a division of PCI Industries, Inc.

   h. Ruskin Company.

   i. Trox USA Inc.

   j. Vent Products Company, Inc.

2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

3. Suitable for horizontal or vertical applications.

4. Frames: Hat shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple or single blade.

   b. Parallel- or opposed-blade design.

   c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.

6. Blade Axles: Stainless steel

7. Bearings:

   a. Molded synthetic.

   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Blade Seals: Neoprene.

9. Jamb Seals: Cambered aluminum.

10. Tie Bars and Brackets: Aluminum.

11. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

D. Jackshaft:

1. Size: 1-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.

2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

2.6 CONTROL DAMPERS

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

1. American Warming and Ventilating; a division of Mestek, Inc.

2. Arrow United Industries; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Duro Dyne Inc.

5. Flexmaster U.S.A., Inc.

6. Greenheck Fan Corporation.

7. Lloyd Industries, Inc.

8. M&I Air Systems Engineering; Division of M&I Heat Transfer Products Ltd.

9. McGill AirFlow LLC.

10. METALAIRE, Inc.

11. Metal Form Manufacturing, Inc.

12. Nailor Industries Inc.

13. NCA Manufacturing, Inc.

14. Ruskin Company.

15. Vent Products Company, Inc.

16. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.

2. Galvanized steel channels, 0.064 inch thick.

3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 8 inches .

2. Opposed-blade design.

3. Galvanized Stainless steel.

4. 0.064 inch thick.

5. Blade Edging: Closed-cell neoprene edging.

E. Blade Axles: 1/2-inch-diameter; stainless steel]; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze.

2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

3. Thrust bearings at each end of every blade.

2.7 FIRE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.

2. Arrow United Industries; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Greenheck Fan Corporation.

5. McGill AirFlow LLC.

6. METALAIRE, Inc.

7. Nailor Industries Inc.

8. NCA Manufacturing, Inc.

9. PHL, Inc.

10. Pottorff; a division of PCI Industries, Inc.

11. Prefco; Perfect Air Control, Inc.

12. Ruskin Company.

13. Vent Products Company, Inc.

14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static rated and labeled according to UL 555 by an NRTL.

C. Fire Rating: 1-1/2 and 3 hours. Coordinate with Architectural Floor Plans for location of building separation ratings.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.8 CEILING DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. McGill AirFlow LLC.

4. METALAIRE, Inc.

5. Nailor Industries Inc.

6. Prefco; Perfect Air Control, Inc.

7. Ruskin Company.

8. Vent Products Company, Inc.

9. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. General Requirements:

1. Labeled according to UL 555C by an NRTL.

2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

F. Fire Rating: 2 and 3 hours. Coordinate with Architectural Floor Plans for location of building separation ratings.

2.9 SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. Greenheck Fan Corporation.

4. Nailor Industries Inc.

5. PHL, Inc.

6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

F. Leakage: Class I

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: Spring return two-position action as manufactured by Belimo – FS Series.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F

6. Electrical Connection: 24VAC or as otherwise coordinated between the Mechanical Contractor and Electrical Contractor/Fire Alarm System.

K. Accessories:

1. Auxiliary switches for position indication.

2. Momentary test switch mounted on ceiling directly below damper assembly.

2.10 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. Greenheck Fan Corporation.

4. Nailor Industries Inc.

5. Ruskin Company.

B. Type: Static; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Fire Rating: 1-1/2 and 3 hours.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

F. Smoke Detector: Integral, factory wired for single-point connection.

G. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

H. Blades: Roll-formed, horizontal, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.

I. Leakage: Class I.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

L. Master control panel for use in dynamic smoke-management systems.

M. Damper Motors: Spring return two-position action as manufactured by Belimo – FS Series.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

6. Electrical Connection: 24VAC or as otherwise coordinated between the Mechanical Contractor and Electrical Contractor/Fire Alarm System.

O. Accessories:

1. Auxiliary switches for position indication.

2. Momentary test switch mounted on ceiling directly below damper assembly.

2.11 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.12 DUCT SILENCERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Industrial Noise Control, Inc.

2. McGill AirFlow LLC.

3. Ruskin Company.

4. Vibro-Acoustics.

C. General Requirements:

1. Factory fabricated.

2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.

3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Shape:

1. Rectangular straight with splitters or baffles.

2. Round straight with center bodies or pods.

3. Rectangular elbow with splitters or baffles.

4. Round elbow with center bodies or pods.

5. Rectangular transitional with splitters or baffles.

E. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G60, galvanized sheet steel, 0.040 inch thick.

F. Round Silencer Outer Casing: ASTM A 653/A 653M, G60, galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.

2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.

3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.052 inch thick.

4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

G. Inner Casing and Baffles: ASTM A 653/A 653M,G60 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

H. Special Construction:

1. Suitable for outdoor use.

2. High transmission loss to achieve STC 45.

I. Connection Sizes: Match connecting ductwork unless otherwise indicated.

J. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.

2. Film-lined type with fill material.

a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.

b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: Mylar.

K. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Flange connections.

2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.

3. Reinforcement: Cross or trapeze angles for rigid suspension.

L. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.

M. Source Quality Control: Test according to ASTM E 477.

1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.

2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 4-inch wg static pressure, whichever is greater.

2.13 TURNING VANES

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

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. METALAIRE, Inc.

4. SEMCO Incorporated.

5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

E. Vane Construction: Double wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.14 REMOTE DAMPER OPERATORS

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

1. Pottorff; a division of PCI Industries, Inc.

2. Ventfabrics, Inc.

3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Surface.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.15 DUCT-MOUNTED ACCESS DOORS

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

1. American Warming and Ventilating; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. Ductmate Industries, Inc.

4. Flexmaster U.S.A., Inc.

5. Greenheck Fan Corporation.

6. McGill AirFlow LLC.

7. Nailor Industries Inc.

8. Pottorff; a division of PCI Industries, Inc.

9. Ventfabrics, Inc.

10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

c. Vision panel.

d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.

e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.

b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.

e. Access Doors Larger Than 24 by 48 Inches Four hinges and two compression latches with outside and inside handles.

2.16 DUCT ACCESS PANEL ASSEMBLIES

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

1. Ductmate Industries, Inc.

2. Flame Gard, Inc.

3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon or 0.0428-inch stainless steel. Access Panel Material shall match duct material.

D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.17 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. Ventfabrics, Inc.

4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.

2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.

2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.18 FLEXIBLE DUCT

A. Inlet VAV Box Connection Ductwork:

1. The duct shall be made from dead soft aluminum sheet, spiral wound into a tube and spiral corrugated. The duct shall be fabricated with a triple mechanical lock to form a continuous secure air tight joint. No adhesives may be used in the manufacture. Duct shall have a factory applied fiberglass insulation blanket with a minimum R-Value of 6.0. This blanket shall be protected by an outdoor vapor barrier composed of fiberglass reinforced aluminum foil and mylar laminate. Ducting shall be cut to size and hand formed to suite job conditions in accordance with the manufacturer's recommendations. The duct shall conform to NFPA 90A, 90B, and be listed by Underwriters Laboratories as 181 Class I Air Duct.

2. Flexible duct shall be Triple Lock Type TL-M as manufactured by Flexmaster or approved equal by Clevaflex or Flexible Tubing Corporation.

3. Maximum length of duct shall be 4'-0" on VAV box inlet connections.

B. Air Device Connection Ductwork: Flexible fiberglass duct with a maximum thermal conductivity of 0.29 BTU/HR - degrees F - Sq.Ft. at 75 degrees F mean temperature with a maximum flame spread rating of 25 and smoke developed rating of 50. Flexible fiberglass duct shall be Owens-Corning Pink AF-FDM minimum R-6 insulation or approved equal. The duct shall conform to NFPA 90A, 90B, and be listed by Underwriters Laboratories as 181 Class I Air Duct.

1. Branch Connections shall be made to main ducts with metal ductwork or flexible fiberglass ductwork as indicated on the drawings and as dictated by the length of the branch duct run. Refer to minimum and maximum flexible duct length and drawing details, balance of branch shall be made in metal duct. All Branches to air device connections shall be provided with a Bellmouth Take-Off connector fitting with damper including gasket, indexed locking quadrant handle, elevated standoff bracket (nominal 2”), nylon closed end bearings, 3/8” square bar shaft, U-bolts as manufactured by Buckley Associates, Inc. Air-Tite Model BMD-B01 or Flexmaster Model CBD-B03; and clamp.

   45 degree Take-Off branch connector fittings with damper may be used in lieu of bellmouth takeoff fittings, where height of connector exceeds the height of the main duct dimension. 45 degree Take-Off branch connector fittings with damper shall include gasket, indexed locking quadrant handle, elevated standoff bracket (nominal 2”), nylon closed end bearings, 3/8” square bar shaft, U-bolts as manufactured by Buckley Associates, Inc. Air-Tite Model 3300D-B01 or Flexmaster Model STOD-B03.

2. Flexible fiberglass duct size shall be same as air device neck size unless otherwise noted.

3. Flexible fiberglass duct length shall be a maximum of 9 feet and a minimum of 6 feet. Support final 90 degree elbow directly over ceiling air-devices (supply and return) with Titus FlexRight nylon strap. Refer to detail on drawings.

C. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.19 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 INSTALLATION

A. Louver Installation:

1. Inspect areas to receive louvers. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.

2. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.

3. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

4. Install joint sealants as specified in Section 07920.

5. Clean louver surfaces in accordance with manufacturer's instructions.

6. Repair minor damaged surfaces as directed by Architect.

B. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

D. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts, and located as far from the air outlet or inlet devices as possible while remaining accessible for balancing. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated.

H. Install fire and smoke dampers according to UL listing.

I. Connect ducts to duct silencers rigidly.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.

2. Upstream and downstream from fire alarm duct detectors at air-handler supply and return ductwork.

3. Upstream and downstream from fire duct mounted air-monitors return ductwork .

4. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

5. Upstream or downstream from duct silencers.

6. Control devices requiring inspection.

7. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.

2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.

4. Head and Shoulders Access: 21 by 14 inches.

5. Body Access: 25 by 14 inches.

6. Body plus Ladder Access: 25 by 17 inches.

M. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Connect terminal units to supply ducts with maximum 48 inch lengths of flexible duct. Do not use flexible ducts to change directions.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

*** END OF SECTION 23 33 00 ***

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SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Registers/Grilles.

2. Diffusers.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.

2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

3. Submit engineering data in a manner to facilitate convenient review of aspiration ability, including temperature and velocity traverses, throw and drop, noise criteria ratings sizes, free area and quality of construction. Outlets shall be selected for maximum noise criteria level as scheduled on drawings.

B. Source quality-control reports.

PART 2 PRODUCTS

2.1 CEILING DIFFUSERS, REGISTERS AND GRILLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide METALAIRE, Inc. or comparable product by one of the following:

1. TITUS

2. Price Industries.

3. Other Substitutes—Submit a written substitution request, prior to bid, to the Architect/Engineer in accordance with Basic Mechanical Requirements. Accepted substitutes will be notified via Addendum.

B. Material: Aluminum.

C. Finish: Baked enamel, white.

D. Mounting: Duct connection.

E. Dampers: Radial opposed blade, adjustable from diffusers and register face.

F. Coordinate frame type with latest Architectural reflected ceiling plan.

G. Refer to schedule on drawings for type and model number.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Provide balancing dampers in diffusers and registers.

E. Paint ductwork visible behind air outlets and inlets matte black.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

*** END OF SECTION 23 37 13 ***

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SECTION 23 74 13

EXTERIOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes outdoor, central-station air-handling units.

B. Related Sections include the following:

1. Common Work Results for HVAC.

2. HVAC Insulation.

1.3 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Performance:

1. Basic Wind Speed: Refer to Structural Drawings

2. Building Classification Category: Refer to Structural Drawings

3. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each AHU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

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

1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Concrete pad to which AHUs will be attached.

2. Location within new screen walled enclosure.

E. Operation and Maintenance Data: For AHUs to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for AHUs.

2. Comply with ARI 270 for testing and rating sound performance for AHUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.

2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

3. Comply with applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

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

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of AHUs that fail in materials or workmanship within specified warranty period.

1. Provide one (1) year warranty from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two spare sets with unit for a total of 3 sets (one at start-up, one at substantial completion and one at final).

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions Division 1.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions Division 1.

B. Store and protect products under provisions of Division 1.

C. Protect units from physical damage by storing off site until site is ready for immediate installation of units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design—Trane

B. Pre-approved Substitutes (Approved to Bid)

1. York (Pre-bid Submittal Required)

2. Carrier (Pre-bid Submittal Required)

3. McQuay (Pre-bid Submittal Required)

C. Other Substitutes—Submit a written substitution request, prior to bid, to the Architect/Engineer in accordance with Specification Section 23 05 00. Accepted substitutes shall be notified via Addendum.

2.2 MANUFACTURED UNITS

A. Unit shall consist of cabinet and frame, supply fan, air filters, chilled water cooling coil, and hot water heating coil. Refer to drawings for components required and access doors.

B. The units shall be front supply airflow, side return airflow. Cooling performance shall be rated in accordance with ARI testing procedures. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be UL listed and labeled.

2.3 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested for 500 hours (above 10 tons) or 1000 hours (10 tons and below) in a salt spray test in compliance with ASTM B117. Manufacturer shall provide written documentation supporting this quality of corrosion protection. Cabinet construction shall allow for all maintenance on one side of the unit. Service panels shall have lifting handles and shall be removed and reinstalled by removing not more than three screws while providing a water and air tight seal. All exposed vertical panels and top covers in the indoor air section of units 10 tons and below shall be insulated with a ½", 1 pound density foil-faced, fire-retardent permanent, odorless glass fiber material. Units above 10 tons shall have matt-faced insulation in lieu of foil-faced. The base of the unit shall be insulated with ½", 1 pound density foil-faced, closed cell material. The unit’s base pan shall have no penetrations. The base of the unit shall have provisions for forklift and crane lifting.

C. Condensate Drain Pans: Formed sections of stainless-steel

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.

2. Drain Connections: Threaded nipple

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.4 FANS

A. Direct-Driven Plenum Supply-Air Fans: Direct-drive, statically and dynamically balanced, draw through in the vertical discharge position. The fan motor(s) shall be permanently lubricated and have built-in thermal overload protection.

B. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

C. Sound data shall be provided using ARI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz. If a manufacturer cannot provide sound data per ARI 260 they may choose to have the air handlers field tested to ensure they meet the specified sound criteria. No exceptions to this requirement will be allowed.

D. Sound data shall not exceed the Basis of Design data listed in the schedule on the drawings. The air handler manufacturer shall be responsible for meeting the required dB. If the submitted dB is higher than the Basis of Design dB, the manufacturer shall be responsible for proving the space RC values are met through acoustical analysis calculations at no expense to the Owner.

2.5 COILS

A. Coils shall be manufactured by the same company as the supplier of the air handling unit. Coils shall be designed with aluminum plate fins and copper tubes.

B. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall be mounted in the unit casing to be accessible for service and can be removed from the unit either through the side or top. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410.

C. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

2.6 AIR FILTRATION

A. Pre-filters located in mixing box shall be disposable type and shall have 2-inch thick media contained in a rigid frame. Filters shall have a rigid supporting maze across both the entering and leaving faces of the media. Filters shall be American Air Filter Model AmAir 300X or Eco-Air C35, 25%-30% efficient based on the ASHRAE 52-76 test method with tolerances conforming to Section 7.4 of ARI Standard 850-78. The filter shall be rated at no more than .20 inches W.G. initial resistance at 300 fpm face velocity. Recommended final resistance of prefilters is 1.2 inches W.G.

B. Final air filters shall be American Air Filter—Varicel II or Eco-Air Ecocell, medium efficiency, extended surface, self-supporting, 4" mini-pleat type. Each filter shall consist of a rigid ultra-fine glass fiber media pack, securely bonded to a double wall enclosing frame.

Filter media shall be ultra-fine fiberglass formed into a thin paper-like mat with a water repellent binder. Construction shall consist of coarser fibers on the air entering side and finer fibers on the air leaving side. The rigid media pack shall consist of media pleats, structurally bonded one to the other. The finished filter shall not exceed 3-3/4" depth in direction of airflow.

The filter shall have an average atmospheric dust spot efficiency of 60-65% as determined by the ASHRAE 52-76 test method. The filter shall be rated at no more than 0.40 inches W.G. initial resistance at 500 fpm face velocity. Recommended final resistance of final filters is 1.5 inches W.G.

The filter shall be classified by Underwriters' Laboratories Class 2 when tested according to UL Standard 900.

2.7 POWER ACCESSORIES

A. Unit shall be provided with a factory installed and wired internal disconnect.

B. Unit shall be provided with a factory installed and wired 115 volt, 12 amp ground fault service receptacle.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of AHUs.

B. Examine roughing-in for AHUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine area for suitable conditions where AHUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation is specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest area drain.

B. Install piping adjacent to AHUs to allow service and maintenance.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at unit..

2. Connect supply ducts to AHUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

3.4 MANUFACTURER’S FIELD SERVICES

A. Manufacturer's Field Service: Manufacturers shall furnish a factory-trained service engineer without additional charge to prepare the machine for operation, start the unit and certify initial field startup. The Manufacturer shall provide a written certification to the Owner that the unit has been prepared and ready for operation. Contractor provided services are not acceptable.

*** END OF SECTION 23 74 13 ***

SECTION 23 82 19

FAN COIL UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fan-coil units and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

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

1. Wiring Diagrams: Power, signal, and control wiring.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

F. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 COORDINATION

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

B. Coordinate size and location of wall sleeves for outdoor-air intake. Refer to drawings for requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two spare sets with unit for a total of 3 sets.

2. Fan Belts: One set of belts for each unit.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

2.2 FAN-COIL UNITS

A. Basis-of-Design Product: Trane or a comparable product by one of the following:

1. York (Pre-bid Submittal Required).

2. Carrier (Pre-bid Submittal Required).

3. McQuay (Pre-bid Submittal Required).

4. Other Substitutes—Submit a written substitution request, prior to bid, to the Architect/Engineer in accordance with Basic Mechanical Requirements. Accepted substitutes will be notified via Addendum.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1-inch thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Main: Insulated galvanized steel with plastic liner with positive slope. Fabricate pans and drain connections to comply with ASHRAE 62.1-2004.

E. Auxiliary Drain Pans: Plastic

F. Chassis: Zinc coated, heavy gauge, galvanized steel with flanged edges, removable panels for servicing with captive screws, knockouts for electrical power and refrigerant piping connections, and completely insulated.

G. Cabinet: Steel with baked enamel finish in manufacturer's standard paint color as selected.

H. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.

I. Hydronic Coils: ½ inch O.D. copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, leak tested with air underwater and rated for a minimum working pressure of 300 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

J. Fan and Motor Board: Removable.

1. Fan: Centrifugal-type, forward-curved, double inlet, double-width wheel of galvanized steel; directly connected to motor with adjustable belt drive. Fan and motor bearings shall be permanently lubricated. (Plastic fan wheels and blower housings are not acceptable.)

2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

a. Special Motor Features: Resilient mounted, multitapped, multispeed with UL Listed internal thermal protection and permanent lubrication. Oversized motors shall be available as an option for high static application. Motor bearings shall be of the sleeve type or ball bearing type with oversized oil reservoirs. Motors shall be permanent split capacitor. Shaded pole motor will not be acceptable. Electrical junction boxes shall be provided for single point power connection.

3. Wiring Termination: Connect motor to chassis wiring with plug connection.

K. Controls: Unit mounted multiple speed switch with auxiliary contacts.

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with elastomeric hangers. Refer to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation

E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

F. Protect units with protective covers during balance of construction.

G. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.

2. Connect condensate drain to indirect waste.

a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FAN COIL SCHEDULE:

A. Refer to drawings.

3.5 FIELD QUALITY CONTROL

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

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

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

*** END OF SECTION 23 82 19 ***

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DIVISION 26—ELECTRICAL

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Basic electrical requirements specifically applicable to Division 26 Electrical.

1.2 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to Division 26 Sections, in addition to Division 01 General Requirements.

1.3 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

1.4 SURVEYS AND MEASUREMENTS

A. Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work. All material take-offs for the site shall be field measured prior to bids.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. Drawings are not to be scaled. The architectural drawings and details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Architect.

B. If directed by the Architect or Engineer, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. At the time of each shop drawing submission, the Contractor shall call the Engineer's attention (in writing) to, and plainly mark on shop drawings, any deviations from the Contract Documents.

D. Samples, drawings, specifications, catalogs, submitted for approval, shall be properly labeled indicating specific service for which material or equipment is to be used, location, section and article number of specifications governing, Contractor's name, and name of job. All equipment shall be labeled to match labeling on contract documents.

E. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

F. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specifications.

G. All shop drawings shall be submitted to the A/E by Contractor no later than 30 days from the day of contract award.

H. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

I. Submit all Division 16 submittals at one (1) time in one (1) integral group. Piece-by-piece submission of individual items will not be acceptable. Engineer may check contents of each submittal set upon initial delivery; if not complete as set forth herein, submittal sets may be returned to Contractor without review and approval and will not be accepted until made complete.

J. At the close of the job, prior to final review, five (5) bound copies of the following shall be submitted by transmittal letter to the Engineer for review and acceptance.

1. Equipment warranties

2. Contractor's warranty

3. Parts list and manuals for all equipment

4. Operating Instructions (in writing)

5. Written instructions on maintenance and care of the system

1.6 REFERENCES

A. ANSI/NFPA 70—National Electrical Code.

B. State Requirements for Educational Facilities (SREF), Chapter 4, Section 423, of the Florida Building Code.

C. NFPA 101—Life Safety Code.

D. Florida Department of Education Accessibility Guidelines and Requirements.

E. NEC 2008

1.7 SUBMITTALS

A. Submit under provisions of Division 1.

B. Proposed Products List: Include Products specified in the following Sections, but not limited to:

1. Section 26 05 19 .....Low-Voltage Electrical Power Conductors and Cables.

2. Section 26 05 26 .....Grounding and Bonding for Electrical Systems.

3. Section 26 05 29 .....Hangers and Supports for Electrical Systems.

4. Section 26 05 33 .....Raceway and Boxes for Electrical Systems.

5. Section 26 05 53 .....Identification for Electrical Systems.

6. Section 26 09 23 .....Lighting Control Devices.

7. Section 26 27 26 .....Wiring Devices.

8. Section 26 28 16 .....Enclosed Switches and Circuit Breakers.

9. Section 26 51 00 .....Interior Lighting.

C. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

1.8 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Electrical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed as equals shall be considered as substitutes. Manufacturers other than the basis of design shall submit a catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute.

Request for approval of substitutions or equals prior to bid must be made in writing. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

C. All requests for substitutions shall be submitted as described in paragraph 1.07, B., and specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution.

D. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

E. Where such approved deviation requires quantity and arrangement of equipment from that specified or indicated on the drawings, any other additional equipment required by the system, at no additional cost to the Owner.

1.9 COOPERATION WITH OTHER TRADES

A. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

C. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.10 ELECTRICAL UTILITY COORDINATION

A. The contractor shall arrange with Utility Company for permanent electric service including payment of Utility Company charges for service.

B. Service shall be underground Service Entrance. System Voltage: 277/480 volts, three phase, four-wire, 60 Hertz.

C. Utility Company: Florida Power and Light Corp.

D. Install service entrance in accordance with Utility Company's rules and regulations.

E. The utility company shall provide the primary utility conduits and the Electrical Contractor shall install the conduits as directed by the utility company. The utility company shall provide and install the primary conductors.

1.11 PROTECTION

A. Protect all work and material provided under this Division from damage. All damaged equipment work or material provided under this Division shall be replaced with new. Rebuilts are not acceptable.

B. Protect all work and equipment until inspected, tested, and accepted. Protect work against theft, injury, or damage; and carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.12 SCAFFOLDING, RIGGING, AND HOISTING

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

1.13 REMOVAL OF RUBBISH

A. This Contractor shall at all times keep premises free from accumulations of waste materials or rubbish caused by his employees or work. At completion of work he shall remove all his tools, scaffolding, materials, and rubbish from the building and site. He shall leave the premises and his work in a clean, orderly, and acceptable condition.

1.14 SAFETY

A. This Contractor shall comply with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.333), Title 29—Labor, Chapter XIII, Bureau of Standards, Department of Labor, Part 1518—Safety and Health Regulations for Construction; and that his housekeeping and equipment be maintained in such a manner that they comply with the Florida Industrial Commission Safety Code and Regulations of the Federal Williams—Steiger Occupational Safety and Health Act of 1970 (OSHA), wherein it states that the Contractor shall not require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

1.15 SUPERVISION

A. This Contractor shall provide a competent, experienced, full time superintendent who is acceptable to the Architect/Engineer and Owner, and who is authorized to make decisions on behalf of the Contractor.

1.16 MATERIAL AND WORKMANSHIP

A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Engineer shall be furnished. Refer to substitutions in this Section.

B. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed with the approval of the Architect and Engineer in accordance with the recommendations of the Manufacturer. This includes the performance of such tests as the Manufacturer recommends.

1.17 QUIET OPERATION AND VIBRATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer and the Owner. In case of moving machinery, sound, or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer and the Owner shall be corrected in an approved manner at no additional expense to the Owner.

1.18 FOUNDATIONS, SUPPORTS, PIERS, ATTACHMENTS

A. This Contractor shall furnish and install all necessary foundations, supports, pads, bases and piers required for all equipment furnished under this Division, and shall submit drawings to the Architect and Engineer for approval before purchase, fabrication or construction of same.

B. For all floor mounted equipment, provide concrete pads which extend six inches (6") beyond equipment base in all directions with top edge chamfered. Inset six inches (6") steel dowel rods into floors to anchor pads. Shop drawings of all foundations and pads shall be submitted to the Architect and Engineer for approval before same are constructed.

C. Construction of foundations, supports, pads, bases, and piers where mounted on the floor, shall be the same materials and same quality of finish as the adjacent and surrounding flooring material.

D. All equipment, unless shown otherwise, shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect and the Engineer, not strong enough shall be replaced as directed.

1.19 ACCESS DOORS FOR WALLS AND CEILINGS

A. Provide flush panel access doors with a 16 gauge steel frame and a 14 gauge steel door panel.

B. Finish is to be primed painted steel.

C. Provide concealed hinges which allow the door to open 175 degrees and have a removable pin.

D. Provide access doors with a locked flush mounted vandal proof spanner head operated steel cams.

E. Provide 1-1/2 hour "B" label door for rated chase walls.

F. Furnish masonry anchors for installation in masonry walls and metal lath wings with casing bead for plaster installation.

G. Provide a minimum 2'-0" by 2'-0" access doors unless shown or noted otherwise on the drawings.

H. Access doors for chase walls shall be mounted 16" off the finish floor.

I. Access doors for electrical equipment shall be a minimum of 12" larger than equipment all around.

1.20 REGULATORY REQUIREMENTS

A. Conform to applicable Codes and Standards as follows:

1. Standard:

a. Certain standard materials and installation requirements are described by reference to standard specifications. These standards are as follows:

NEMA..... National Electrical Manufacturers Association.

UL ..... Underwriters Laboratories.

ANSI..... American National Standards Institute.

For additional standards and requirements see other sections of the specifications.

Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition at the time project is bid unless otherwise specified herein.

2. Codes and Rules:

a. All material furnished and all work installed shall comply with the following codes as they apply to this project:

- NFPA 70 and NFPA 101.
- Regulations of the Florida Industrial Commission Concerning Safety.
- Applicable County, State, and Local Building Codes.
- Local and State Fire Marshal Rules and Regulations.
- Chapter 4A-47, Florida Administrative Code - Uniform Fire Safety Standards for Elevators.
- Occupational Safety and Health Agency Standards (OSHA).
- Florida State Board of Health Rules and Regulations.
- Florida Building Code.
- State Requirements for Educational Facilities (SREF), Chapter 4, Section 423, of the Florida Building Code.

Applicable codes shall be those adopted by the authority having jurisdiction at the time project is bid.

3. Permits, Fees and Inspections

a. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all necessary approvals of all governmental departments having jurisdiction.

b. Obtain all required certificates of inspection for his work and deliver to the Owner/Engineer the same certificates before request for acceptance and final payment for the work.

c. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

d. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

B. Conform to Florida Department of Education Accessibility Guidelines and Requirements.

1.21 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.

C. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

D. The scope of the work included under this Division of the Specifications shall include complete electrical systems as shown on the plans and as specified herein. The General Conditions and Special Conditions of these specifications shall form a part and be included under this Section of the Specifications. Provide all supervision, labor, material, equipment, machinery, factory trained personnel, and any and all other items necessary to complete the electrical systems. All items of equipment are specified in the singular; however, provide and install the number of items of equipment as indicated on the drawings, and as required for complete systems.

1.22 SEQUENCING AND SCHEDULING

A. Construct Work in sequence under provisions of Division 1.

1.23 LICENSE

A. The Subcontracting Firm for the electrical and systems installation shall be licensed by the State of Florida and the local authorities, regularly engaged in the installation of electrical systems and other related equipment. The Subcontracting Firm shall be familiar with all local conditions including interpretations, codes and shall have at least 5 years of successful installation experience on similar projects of the same magnitude and scope.

The Subcontracting Firm shall list at least three projects it has successfully completed over the last five years for proof of experience of this caliber. This list shall be included with submittals for review by Architect/Engineer. The Subcontracting Firm shall hold a Florida State Certified Electrical Contractor license for this project. The Subcontracting firm for the fire alarm system shall be a certified "EF" installer.

1.24 AS-BUILT DRAWINGS

A. This Contractor shall provide AutoCad as-built drawings and copies of each AutoCad file on CD before final payment will be issued.

*** END OF SECTION 26 05 00 ***

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SECTION 26 05 10

ELECTRICAL DEMOLITION FOR REMODELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical Demolition.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

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

PART 3 EXECUTION

3.1 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 and existing record documents. Report discrepancies to the Architect/Engineer before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with utility company and school facility.

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 and Distribution System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner at least one week before partially or completely disabling system. Minimize outage duration. 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. Notify the Owner at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Relocate system to temporary office location. Extend all existing and temporary fire alarm circuit and control wiring to this location.

F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Notify the Owner and telephone utility company at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

G. Existing Intercom System: Maintain existing system in service. Relocate system to temporary office location. Extend all existing and new intercom circuits to this location. Disable system only to make switchovers and connections. Notify the Owner at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Furnish and install temporary wiring and intercom circuits as required.

H. Furnish, install, and maintain temporary power and lighting for all areas and for trades. Lighting levels shall equal the existing condition prior to demolition work.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 and this Section.

B. Prior to any demolition, this Contractor shall survey the building and paint a large red ‘R’ on the equipment to be removed as coordinated with the architectural and HVAC plans and roofer. If any item(s) is incorrectly tagged, then this Contractor shall clean off the paint so there is no confusion.

C. If any conflicts arise in the field as to which equipment, ductwork, etc., is to be removed, then this Contractor shall notify the Owner/Engineer in writing and shall include a sketch and description of the field conflict for further direction.

D. In areas where demolition is required of this Contractor, then this Contractor shall be responsible for all phases of demolition, including, but not limited to, removal, storage, and reinstallation of items to remain.

E. Remove, relocate, and extend existing installations to accommodate new construction.

F. Remove abandoned wiring to source of supply.

G. Remove exposed, abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors and patch surfaces.

H. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed or remove boxes for wall to be patched.

I. Disconnect and remove abandoned panelboards and distribution equipment.

J. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

K. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

L. Repair adjacent construction and finishes damaged during demolition and extension work.

M. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

N. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

O. Coordinate with roofer and assist in removal of all roof mounted electrical conduit devices, equipment, etc., to be removed as indicated on the roofing drawings and HVAC drawings.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or 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.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1.

*** END OF SECTION 26 05 10 ***

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

3. Sleeves and sleeve seals for cables.

4. Conductor sizes are based on copper.

B. Related Sections include the following:

1. Section 26 05 33 .....Raceway And Boxes For Electrical Systems.

2. Section 26 05 53 .....Identification For Electrical Systems.

1.3 REFERENCES

A. ANSI/NFPA 70—National Electrical Code.

B. NEMA WC5—Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.4 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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

C. Comply with NFPA 70 where wire and cable is not shown.

1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

B. Determine required separation between cable and other work.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

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

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

1. Alcan Products Corporation; Alcan Cable Division.

2. American Insulated Wire Corp.; a Leviton Company.

3. General Cable Corporation.

4. Senator Wire & Cable Company.

5. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

E. Multiconductor Cable: Comply with NEMA WC 70 for Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

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

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

1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

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

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

1. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex Co.

4. Pipeline Seal and Insulator, Inc.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Carbon steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN-XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

J. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

L. Class 1 Control Circuits: Type THHN-THWN, in raceway.

M. Class 2 Control Circuits: Type THHN-THWN-TFFN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Concealed Dry Interior Locations: Use only building wire and cable (all types) in raceway.

E. Exposed Dry Interior Locations: For feeders, branch circuits, and class 1 remote control circuits, use only building wire in raceway. For class 2 or 3 control cable and power limited fire protective signaling cables run in raceway.

F. Above Accessible Ceilings: For feeders, branch circuits and class 1 remote control cables use only building wire in raceway. For class 2 or 3 remote control cables run exposed. For power limited fire protective signaling cables run in raceway.

G. Wet or Damp Interior Locations: For feeders, branch circuits and class 1 remote control cables use only building wire in raceway. For class 2 or 3 remote control cable and power limited fire protective signaling cables run in raceway.

H. Exterior Locations: For feeders, branch circuits and class 1 remote control cables use only building wire run in raceway. For class 2 or 3 remote control cables and fire protective signaling cables run in raceway.

I. Underground Installations: For feeders, branch circuits and class 1 remote control cables use only building wire run in raceway. For class 2 or 3 remote control cables and for power limited fire protective signaling cables run in raceway.

J. Use wiring methods indicated on Drawings.

K. Each computer/clean power receptacle and lighting circuits shall have a dedicated neutral conductor.

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.

N. All conductors size #6 and smaller shall be color coded insulation. Equipment grounding conductors #6 and smaller to have green or bare exterior finish per NEC 250-119(A). Grounded conductors (neutral) #6 and smaller to have a white or grey exterior finish per NEC 200-6. Conductors size #4 and larger shall be color code by use of colored plastic tape applied within 6" of each conductor end. All color coding shall be with the same color being used with its respective phase or bus through the entire job as follows:

208/120 VOLTS	277/480 VOLTS
Phase A.....Black	Phase A.....Brown
Phase B.....Red	Phase B.....Orange
Phase C.....Blue	Phase C .....Yellow
Neutral.....White	Neutral.....Gray
Ground .....Green	Ground .....Green

O. Grounding conductors shall be identified with a continuous outer finish that is either green, or green with one or more yellow stripe.

P. Protect exposed cable from damage.

Q. Support cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

R. Neatly train and lace wiring inside boxes, equipment, and panelboards.

S. Clean conductor surfaces before installing lugs and connectors.

T. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

U. 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.

V. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

W. Terminate spare conductors with electrical tape.

X. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

Y. Splice only in accessible junction boxes.

Z. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both wall surfaces.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

a. Subpanels.

b. Mechanical equipment with service of 200 amps and greater.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan on equipment and connections identified by the Engineer. Remove box and equipment covers so splices are accessible to portable scanner.

a. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

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

*** END OF SECTION 26 05 19 ***

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1. Underground distribution grounding.

2. Common ground bonding with lightning protection system.

1.3 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to metallic water service, concrete encased rebar, building steel, and to supplementary grounding electrodes.

B. Ground each separately-derived system neutral to nearest effectively grounded metallic water pipe, concrete encased rebar, nearest effectively grounded building structural steel member, and separate grounding electrode.

C. Provide communications system grounding conductor at point of service entrance and connect to separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

E. Install lightning surge protection on all service entrances as shown on drawings. Lightning surge protector shall have a minimum withstand rating of a Class "C" test.

F. Bond metallic gas piping with #4 AWG copper conductor.

1.4 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.

2. Ground rods.

3. Ground rings.

4. Grounding arrangements and connections for separately derived systems.

5. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. Grounding system resistance shall not exceed 10 ohms.

E. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Submit test results to Engineer for review and approval immediately upon completing the test and prior to energizing new utility service. The testing shall include sufficient ground resistant data readings from distances up 100 feet away from the ground triad in order to plot a distinct plateau between two distinctive slopes.

PART 2 PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with insulators, length as required for number of terminations plus 25 percent future capacity.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; sectional type, 3/4 inch diameter by 10 feet, two (2) rods coupled together for overall length of 20 feet.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Ring Conductors: Install bare-copper conductor, No. 4/0 AWG minimum when indicated on the drawings to provide.

1. Bury at least 24 inches below grade.

2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall, 6 inches above finished floor, unless otherwise indicated.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Clamp connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.

2. Lighting circuits.

3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.

7. Armored and metal-clad cable runs.

8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Metal and Concrete Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors. Provide ground rod at each location.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96A when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Ground Ring (when identified and called for on the drawings): Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of item indicated.

1. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 24 inches from building foundation.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Report measured ground resistances that exceed the following values:

1. Main service equipment and distribution gear.

2. Separately derived system (i.e., transformers, uninterruptible power supply, engine generators).

3. Grounding system resistance shall not exceed 10 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

F. Supplement by adding additional ground rods to achieve 10 ohms.

*** END OF SECTION 26 05 26 ***

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

3. Supports/safety wire and chains for light fixtures and equipment.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting and Theatrical Lighting."

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.

4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut; Tyco International, Ltd.

g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

B. Located In or Around Cooling Tower Yards: Pipe hangers, equipment supports, miscellaneous structure components, hardware, bolts, washers, nuts, screws, etc., shall be non-metallic polyester resin, vinyl ester resin, fiberglass, glass reinforced polyurethane, or 316 stainless steel.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Shall not be used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

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

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment. After fabrication shall be coated with hot-dipped galvanized with a minimum of 1.50 oz/ft on all sides.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

C. Field cuts shall be zinc coated.

2.3 SAFETY WIRE, CABLES, AND CHAIN

A. Chain, General Specifications: Equivalent to Campbell Chain Company's specified system of steel, electrically welded standard finish (do not galvanize or electroplate), in continuous lengths. Comply with Manufacturer's recommendations.

B. Drop Forged Chain Fittings (eye bolts, pad eyes, inks, chain shackles, snaps, anchor shackles, swivels, turn buckles): Of the same materials and finish as the chain and of the same or greater working load limits, of the same manufacturer or as may be specifically recommended by the chain manufacturer.

C. General Specifications for Wire: 8-gauge galvanized annealed steel wire (multiple strands of lesser gauge will not be considered acceptable). Each wire shall, itself, be looped through the building structural framing above and not to other wiring systems. The angle of the wires shall be kept as vertical as possible and not over 45 degrees from the vertical.

D. Cable for Exposed-to-Public-View-Applications: Where suspended chandeliers, light fixtures, or special equipment occurs, stainless steel flexible aircraft cable or stainless steel flexible marine cable, 302/304, as manufactured by Paulsen, or equal, or Sailbryte as manufactured by Macwhyte corrosion resistant stainless steel or better, right regular lay, in continuous lengths, shall be used. Comply with manufacturer's recommendations.

E. Forged and other stainless steel fittings for stainless steel aircraft or marine cable (turnbuckles, swagings, Nicro-Press sleeves, wire rope clips, use only in concealed positions), connecting links shoulder rivets, jaw fittings, eye fittings, lifting eyes, thimbles, swivels, eye nuts, heavy thimbles, clevis nuts, eye pads, shoulder pins); of same material, of same or greater working loads limits as the cable, of the same manufacturer or as recommended by the cable manufacturer, of type 304/316 electro-polished finish, drop forged, non-magnetic (when available for particular fitting). Manufactured by Merrill or equal. See Workmanship paragraph below.

F. Stainless steel cable for loads (per cable) not exceeding 100 lbs.: 3/32" 7x19 with tensile load limit of 920 lbs. minimum.

G. Stainless steel cable for loads (per cable) not exceeding 500 lbs.: 3/16" 7x19 with tensile load limit of 3,700 lbs. minimum.

H. Workmanship: Stainless steel cable is required to be used only in areas where such is exposed to "public view" therefore only fittings designed for cold swaging or Nicro-Press fittings or swagless terminals such as Macwhyte Norseman Terminals are to be used whereby no wire ends, nuts, pins, or cotter keys, or clips are visible. Swaging shall be done only with a rotary swager (not a roll swager.) Manufacturer's recommendations and specifications shall be adhered to. Pertinent portions of the booklet Wire Rope Facts published by Banks Wire Rope and Sling, Inc. (available in Tampa) and Construction Care and Maintenance of Marine Rigging by Macwhyte Wire Rope Company (available at the Lazzerette Company) which may pertain also to stainless steel cable, shall be adhered to.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Existing Concrete: Expansion anchor fasteners.

4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

5. To Light Steel: Sheet metal screws.

6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[by means that meet seismic-restraint strength and anchorage requirements].

7. Do not drill structural steel members.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

*** END OF SECTION 26 05 29 ***

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Section 26 05 26 .....Grounding and Bonding for Electrical Systems.

2. Section 26 05 29 .....Hangers and Supports for Electrical Systems.

3. Section 26 05 53 .....Identification for Electrical Systems.

4. Section 26 27 26 .....Wiring Devices.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: All raceway types, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.

b. Frame and cover design.

c. Grounding details.

d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.

2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.

4. Anamet Electrical, Inc.; Anaconda Metal Hose.

5. Electri-Flex Co.

6. Manhattan/CDT/Cole-Flex.

7. Maverick Tube Corporation.

8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1. Zinc coated ¾" minimum.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. EMT: ANSI C80.3. ¾" minimum.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Steel set screw or steel compression. One inch (1") and smaller shall be insulated throughout.

2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

3. Fittings for EMT: Steel, set-screw or compression type.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.; Anaconda Metal Hose.

3. Arnco Corporation.

4. CANTEX Inc.

5. CertainTeed Corp.; Pipe & Plastics Group.

6. Condux International, Inc.

7. ElecSYS, Inc.

8. Electri-Flex Co.

9. Lamson & Sessions; Carlon Electrical Products.

10. Manhattan/CDT/Cole-Flex.

11. RACO; a Hubbell Company.

12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC and EPC-80-PVC. ¾" minimum.

D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

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

1. Arnco Corporation.

2. Endot Industries Inc.

3. IPEX Inc.

4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

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

1. Cooper B-Line, Inc.

2. Hoffman.

3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type or screw-cover type, as indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

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

1. Hoffman.

2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect/Engineer.

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

a. Thomas & Betts Corporation.

b. Walker Systems, Inc.; Wiremold Company (The).

c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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

a. Butler Manufacturing Company; Walker Division.

b. Enduro Systems, Inc.; Composite Products Division.

c. Hubbell Incorporated; Wiring Device-Kellems Division.

d. Lamson & Sessions; Carlon Electrical Products.

e. Panduit Corp.

f. Walker Systems, Inc.; Wiremold Company (The).

g. Wiremold Company (The); Electrical Sales Division.

2.7 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.

2. EGS/Appleton Electric.

3. Erickson Electrical Equipment Company.

4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

6. O-Z/Gedney; a unit of General Signal.

7. RACO; a Hubbell Company.

8. Robroy Industries, Inc.; Enclosure Division.

9. Scott Fetzer Co.; Adalet Division.

10. Spring City Electrical Manufacturing Company.

11. Thomas & Betts Corporation.

12. Walker Systems, Inc.; Wiremold Company (The).

13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular. Hubbell B-4236 Series, Walker 880CS Series.

E. Floor Box Covers: Polished solid brass.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

I. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Plywood backboard, marine-grade, ¾" thick.

7. Copper Ground Bar with #6 Copper Grounding: Electrode conductor to building steel.

8. Terminal Blocks: ANSI/NEMA ICS 4: UL listed. Channel mounted tubular pressure screw connectors, rated 300 volts.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Gray.

2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC" or "COMMUNICATION."

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

8. All in-ground boxes shall be traffic bearing type.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

2. Basis-of-Design Product: Subject to compliance with requirements, provide Quazite PG Series or a comparable product by one of the following:

a. Armorcast Products Company.

b. Carson Industries LLC.

c. CDR Systems Corporation.

d. NewBasis.

2.9 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.10 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex Co.

4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Carbon steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.

2. Concealed Conduit, Aboveground: Rigid steel conduit or EMT.

3. Underground Conduit: RNC, Type EPC-40 PVC, direct buried.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete. SCTE 77, Tier 15 structural load rating.

b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

a. Loading dock.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

5. Damp or Wet Locations: Rigid steel conduit.

6. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable in raceway or EMT.

7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.

8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable in raceway; Riser-type, optical fiber/communications cable in raceway. Outside Plant, Plenum-type, optical fiber/communications cable in RGC or IMC.

9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs: Metallic raceways shall be coated with Bitumastic.

1. Run conduit parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Change from Type EPC-40-PVC to rigid steel conduit or IMC before rising above the floor.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use #12 insulated conductor or polypropylene line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.

2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.

3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.

1. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Install insulated bushing on all conduits. Install grounded metal bushing with lug on all mains, sub-feeders, switchboards, panelboards, transformers, chillers, disconnects, starters, and equipment rated at 100 amps and above.

S. Do not install flush mounting boxes back to back in walls. Provide minimum 12 inch separation. Provide 24 inch minimum separation in acoustic rated walls.

T. Install boxes to preserve fire resistance rating of partitions and other elements using materials and methods that are UL listed and tested.

U. Use stamped steel bridges to fasten flush mounted outlet box between studs.

V. Existing Walls, Public Areas, Classrooms, Offices, Restrooms, Hallways, etc.: Conduit and boxes shall be concealed. Saw cut walls and floor slab. Make arrangements with General Contractor to patch all areas.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Division 31 Section "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

7. Transition from PVC (EPC-40 and EPC-80) to rigid galvanized conduit 5'-0" out from building foundation walls.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

*** END OF SECTION 26 05 33 ***

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways, Junction Boxes, and Pullboxes Carrying Circuits at 600 V or Less:

1. Emergency Distribution System: Red.

2. 480 Volt, Single and Three Phase System: Blue.

3. 208 Volt, Single and Three Phase System: Black.

4. Fire Alarm System: Red.

5. Motor and Other Control Systems: Purple.

6. Telephone System: Yellow.

7. Television System: Brown.

8. Security System: White.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.

2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.4 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch grommets in corners for mounting.

3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F.

5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 10-foot maximum intervals in straight runs, and at 5-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with self-adhesive vinyl label, self-adhesive vinyl tape applied in bands, or painted bands. Install labels at 10-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.

2. Power.

3. UPS.

4. Lighting.

5. Fire Alarm.

6. Controls.

C. Power-Circuit Conductor Identification, 600 V or Less: For all conductors.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.

2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.

    b. Controls with external control power connections.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.

    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.

    b. Enclosures and electrical cabinets.

    c. Access doors and panels for concealed electrical items.

    d. Switchgear.

    e. Switchboards.

    f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

    g. Substations.

    h. Emergency system boxes and enclosures.

    i. Motor-control centers.

j. Enclosed switches.

k. Enclosed circuit breakers.

l. Enclosed controllers.

m. Variable-speed controllers.

n. Push-button stations.

o. Power transfer equipment.

p. Contactors.

q. Remote-controlled switches, dimmer modules, and control devices.

r. Battery-inverter units.

s. Battery racks.

t. Power-generating units.

u. Monitoring and control equipment.

v. UPS equipment.

*** END OF SECTION 26 05 53 ***

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor and indoor photoelectric switches.
3. Indoor occupancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.
6. Emergency shunt relays.

B. Related Sections include the following:

1. Division 26 Section "Central Dimming Controls" for architectural dimming system equipment.
2. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.
3. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.
4. Division 26 Section "Theatrical Lighting" for theatrical lighting controls.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 TIME SWITCHES

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

1. Intermatic, Inc.

2. Leviton Mfg. Company Inc.

3. Lightolier Controls; a Genlyte Company.

4. Lithonia Lighting; Acuity Lighting Group, Inc.

5. Paragon Electric Co.; Invensys Climate Controls.

6. Square D; Schneider Electric.

7. TORK.

8. Touch-Plate, Inc.

9. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: DPDT or DPST as required.

2. Contact Rating: 30-A inductive or resistive, 240-V ac, 20-A ballast load, 120/240-V ac, and 20 A ballast load, 277/480-V ac.

3. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.

4. Astronomic Time: All channels.

5. Battery Backup: For schedules and time clock.

C. Electromechanical-Dial Time Switches: Type complying with UL 917.

1. Contact Configuration: SPDT or DPDT.

2. Contact Rating: 30-A inductive or resistive, 240-V ac; 20-A ballast load, 120/240-V ac; 20A ballast load, 277/480 V ac.

3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.

4. Astronomic time dial.

5. Eight-Day Program: Uniquely programmable for each weekday and holidays.

6. Skip-a-day mode.

7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

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

1. Intermatic, Inc.

2. Lithonia Lighting; Acuity Lighting Group, Inc.

3. Paragon Electric Co.; Invensys Climate Controls.

4. Square D; Schneider Electric.

5. TORK.

6. Touch-Plate, Inc.

7. Watt Stopper (The).

B. Description: Solid state, with SPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.

2. Time Delay: 30-second minimum, to prevent false operation.

3. Lightning Arrester: Air-gap type.

4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.3 INDOOR PHOTOELECTRIC SWITCHES

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

1. Allen-Bradley/Rockwell Automation.

2. Eaton Electrical Inc; Cutler-Hammer Products.

3. Grasslin Controls Corporation; a GE Industrial Systems Company.

4. Intermatic, Inc.

5. Lithonia Lighting; Acuity Lighting Group, Inc.

6. MicroLite Lighting Control Systems.

7. Paragon Electric Co.; Invensys Climate Controls.

8. Square D; Schneider Electric.

9. TORK.

10. Touch-Plate, Inc.

11. Watt Stopper (The).

B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13 A tungsten at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

3. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.

4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.

5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

C. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

3. Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.

4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.

5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.4 INDOOR OCCUPANCY SENSORS

A. Manufacturers

1. DLM by WattStopper.

2. nLight by Sensor Switch.

B. Provide a lighting control design using the occupancy sensor types indicated below in the application suitable for the given lighting area to be controlled. Refer to the Electrical Lighting Drawings for the areas and lighting circuits to be controlled. Submit shop drawings indicating the layout and sensor type applicable to the area of coverage and size/type room to be controlled.

C. Coordinate with the Division 23 Control Contractor for interface to the HVAC Automation System. Occupancy sensor shall be wired to the Automatic Control System (Reference Section 23 09 00 Instrumentation and Control for HVAC) through a network bridge relay as an input into the controller. This input shall be used by the Control System to reduce the rooms minimum airflow setpoint to zero (adjustable) as a Energy Efficiency Measure.

D. Dual Technology Sensor (Ceiling and Wall Type)

1. The Dual Technology sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.

2. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.

3. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.

4. Ceiling mounted sensors shall have a flat, unobtrusive appearance and provide 360° coverage.

5. To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.

6. Provide complete with digital room controller and low voltage light switch as required for operation and compatibility with lighting system.

7. Sensors shall have a time delay that is adjusted automatically or shall have a fixed time delay of 5 to 30 minutes, set by DIP switch.

8. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

9. The sensors shall feature RJ45 port for low voltage wiring, which makes installation easier.

10. Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

11. Sensors shall have standard 5 year warranty and shall be UL listed.

E. Wall Switch Sensor

1. These sensors are only permitted in rooms that are less than 200 square feet and each space shall be evaluated by the Engineer during submittal review for appropriate coverage.

2. The passive infrared sensor shall be a completely self contained control system that replaces a standard toggle switch. Switching mechanism shall be a latching air gap relay, compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.

3. Sensor shall be capable of detecting presence in the control area by detecting changes in infrared energy. Small movements shall be detected, such as when a person is writing while seated at a desk.

4. Sensor shall have a time delay that is adjusted automatically or shall have a fixed time delay of 5, 10, 15, 20 or 30 minutes, walk-through mode, or test mode, set by DIP switch. In walk-through mode, lights shall turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

5. Sensor shall have the choice of light flash alert and/or audible alert of impending light shut off, selectable with DIP switch.

6. Sensor shall have sensitivity adjustment that is set to either automatic or reduced sensitivity, and is set with DIP switch.

7. Sensor shall have a built-in light level feature selectable with DIP switch. During set up of light level control, sensor shall learn desired hold-off level, requiring only one step.

8. Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.

9. Sensor shall operate at universal voltages of 120, 230, or 277 VAC; 50/60 Hz.

10. Sensor shall have no minimum load requirement and shall be capable of switching 0 to 800 watts fluorescent/incandescent or 1/6 hp @ 120VAC, 50/60 Hz; 0 to 1200 watts fluorescent or 1/6 hp @ 230/277VAC, 50/60 Hz.

11. Sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.

12. Sensor shall utilize a temperature compensated, dual element sensor, and a multi-element Fresnel lens.

13. For vandal resistance, Fresnel lens shall be made of hard, 1.0mm Poly IR 2 material that offers greater sensitivity to motion and superior detection performance. Lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

14. To assure detection at desktop level uniformly across the space, sensor shall have a 2 level, 28 segment, multi-element Fresnel lens system.

15. Sensor shall cover up to 300 sq ft for walking motion, with a field of view of 180 degrees.

16. Adjustments and mounting hardware shall be concealed under a removable, tamper resistant cover to prevent tampering of adjustments and hardware.

17. For safety, sensor shall have a 100% off switch with no leakage current to the load.

18. Sensor shall not protrude more than 3/8” from the wall and shall blend in aesthetically.

19. Sensor shall have standard 5 year warranty and shall be UL listed.

F. Spare Sensors and Parts

1. Provide ten (10) percent spare of each sensor type, power pack and device installed in the facility or five of each type, whichever is greater.

2.5 OUTDOOR MOTION SENSORS (PIR)

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

1. Bryant Electric; a Hubbell Company.

2. Hubbell Lighting.

3. Lithonia Lighting; Acuity Lighting Group, Inc.

4. Paragon Electric Co.; Invensys Climate Controls.

5. RAB Lighting, Inc.

6. TORK.

7. Watt Stopper (The).

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.

b. Relay: Internally mounted in a standard weatherproof electrical enclosure.

c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

3. Bypass Switch: Override the on function in case of sensor failure.

4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

C. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

D. Detection Coverage: Up to 52.5 feet, with a field of view of 270 degrees.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.6 LIGHTING CONTACTORS

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

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE Industrial Systems; Total Lighting Control.
5. Grasslin Controls Corporation; a GE Industrial Systems Company.
6. Hubbell Lighting.
7. Lithonia Lighting; Acuity Lighting Group, Inc.
8. MicroLite Lighting Control Systems.
9. Square D; Schneider Electric.
10. TORK.
11. Touch-Plate, Inc.
12. Watt Stopper (The).
13. Siemens.

B. Description: Electrically operated and mechanically or electrically held, as scheduled, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Enclosure: Comply with NEMA 250.
3. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation.

2.7 EMERGENCY SHUNT RELAY

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

1. Lighting Control and Design, Inc.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 or 277 V to match system's voltage.

2.8 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

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

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

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

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

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SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Wall-box motion sensors.
5. Isolated-ground receptacles.
6. Hospital-grade receptacles.
7. Snap switches and wall-box dimmers.
8. Solid-state fan speed controls.
9. Wall-switch and exterior occupancy sensors.
10. Pendant cord-connector devices.
11. Cord and plug sets.
12. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:

1. Division 26 Section "Raceways and Boxes for Electrical Systems."
2. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 8300 (duplex).

b. Hubbell; HBL8310 (single), HBL8300H (duplex).

c. Leviton; 8310 (single), 8300 (duplex).

d. Pass & Seymour; 9301-HG (single), 9300-HG (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; CR 5253IG.

b. Leviton; 5362-IG.

c. Pass & Seymour; IG6300.

3. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; TR8300.

b. Hubbell; HBL8300SG.

c. Leviton; 8300-SGG.

d. Pass & Seymour; 63H.

3. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; HGF20.

b. Hubbell; HGF8300.

c. Leviton; 6898-HG.

d. Pass & Seymour; 2091-SHG.

2.4 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5362BLS.

b. Hubbell; HBL5362SA.

c. Leviton; 5380.

3. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

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

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

a. Cooper Crouse-Hinds.

b. EGS/Appleton Electric.

c. Killark; a division of Hubbell Inc.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; L520R.

b. Hubbell; HBL2310.

c. Leviton; 2310.

d. Pass & Seymour; L520-R.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).

b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221PL for 120 V and 277 V.

b. Hubbell; HPL1221PL for 120 V and 277 V.

c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.

d. Pass & Seymour; PS20AC1-PLR for 120 V.

3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221L.

b. Hubbell; HBL1221L.

c. Leviton; 1221-2L.

d. Pass & Seymour; PS20AC1-L.

3. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995.

b. Hubbell; HBL1557.

c. Leviton; 1257.

d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995L.

b. Hubbell; HBL1557L.

c. Leviton; 1257L.

d. Pass & Seymour; 1251L.

2.10 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 1000 W; dimmers shall require no derating when ganged with other devices. Match load shown on drawings.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.11 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Three-speed adjustable rotary knob, 1.5 A.

2.12 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 6111 for 120 V, 6117 for 277 V.

b. Hubbell; WS1277.

c. Leviton; ODS 10-ID.

d. Pass & Seymour; WS3000.

e. Watt Stopper (The); WS-200.

3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

B. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; AT120 for 120 V, AT277 for 277 V.

b. Leviton; ODS 15-ID.

3. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

C. Exterior Occupancy Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Leviton; PS200-10.

b. Watt Stopper (The); EW-100-120.

3. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.13 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: Smooth stainless steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.14 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type or flap-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular or round, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray for data/communications outlets, ivory for convenience outlets, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening for four CAT 5 jacks.

2.15 POKE-THROUGH ASSEMBLIES

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

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

1. Hubbell Incorporated; Wiring Device-Kellems.

2. Pass & Seymour/Legrand; Wiring Devices & Accessories.

3. Square D/ Schneider Electric.

4. Thomas & Betts Corporation.

5. Wiremold Company (The).

6. Evolution.

C. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Flush type with two (2) duplex receptacles and space for four (4) RJ-45 jacks.

2. Size: Selected to fit nominal 6-inch cored holes in floor and matched to floor thickness.

3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

4. Closure Plug: Arranged to close unused 6-inch cored openings and reestablish fire rating of floor.

5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.16 MULTIOUTLET ASSEMBLIES

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

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

1. Hubbell Incorporated; Wiring Device-Kellems.

2. Wiremold Company (The).

C. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

D. Raceway Material: Metal, with manufacturer's standard finish.

E. Wire: No. 12 AWG.

2.17 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch-square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.

2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.

3. Finishes: Manufacturer's standard painted finish and trim combination.

4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.

5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.

6. Voice and Data Communication Outlets: Four RJ-45 Category 5e jacks.

2.18 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Toggle Switches: Ivory.

2. Convenience Receptacles: Ivory.

3. Data/Communication Receptacles: Gray.

4. GFCI Receptacles: Ivory.

5. Wiring Devices Connected to Emergency Power System: Red.

6. TVSS Devices: Blue.

7. Isolated-Ground Receptacles: Orange.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.

b. Straighten conductors that remain and remove corrosion and foreign matter.

c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.

2. Test Instruments: Use instruments that comply with UL 1436.

3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

*** END OF SECTION 26 27 26 ***

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 1000 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than fourteen (14) days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Owner's written permission.

4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: One for each size and type.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac for voltage applied, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open when specified with VFD mounted separately.

6. Hookstick Handle: Allows use of a hookstick to operate the handle.

7. Lugs: Mechanical type, suitable for number, size, and conductor material.

8. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac for voltage applied, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open when specified with VFD mounted separately.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 RECEPTACLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 240 or 600-V ac for voltage applied, 30 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 240 or 600-V ac for voltage applied, 30 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

1. Receptacle Manufacturer and Catalog Number: NEMA type configuration as shown on drawings.

2.4 SHUNT TRIP SWITCHES

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

1. Cooper Bussmann, Inc.

2. Ferraz Shawmut, Inc.

3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power of enough capacity to operate shunt trip, connected pilot, and indicating and control devices. Refer to drawings to ensure separate 120 V source not provided by other means.

E. Accessories:

1. Oiltight key switch for key-to-test function.

2. Oiltight green ON pilot light.

3. Isolated neutral lug; 100 percent rating.

4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.

5. Form C alarm contacts that change state when switch is tripped.

6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Long- and short-time pickup levels.

2. Long- and short-time time adjustments.

3. Ground-fault pickup level, time delay, and I2t response.

E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

F. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self- powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact when indicated on drawings.

2.6 MOLDED-CASE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.7 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

6. Mechanical Cooling Tower Areas: NEMA 250, Type 4X, stainless steel.

7. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

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

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

*** END OF SECTION 26 28 16 ***

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5. Retrofit kits for fluorescent lighting fixtures.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Central Dimming Controls or Modular Dimming Controls" for architectural dimming systems.
3. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
4. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
5. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.

3. Ballast.

4. Energy-efficiency data.

5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."

6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."

7. Life, output, and energy-efficiency data for lamps.

8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.

b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

1. Wiring Diagrams: Power and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.

2. Suspended ceiling components.

3. Structural members to which suspension systems for lighting fixtures will be attached.

4. Other items in finished ceiling including the following:

   a. Air outlets and inlets.

   b. Speakers.

   c. Sprinklers.

   d. Smoke and fire detectors.

   e. Occupancy sensors.

   f. Access panels.

5. Perimeter moldings.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

1. Lamps: Specified units installed.

2. Accessories: Cords and plugs.

E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

F. Qualification Data: For agencies providing photometric data for lighting fixtures.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

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

C. Comply with NFPA 70.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.6 COORDINATION

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

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: One year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

3. Battery and Charger Data: One for each emergency lighting unit.

4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

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

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

3. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.

b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

K. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."

1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.

2. Heat Removal Units: Air path leads through lamp cavity.

3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.

4. Dampers: Operable from outside fixture for control of return-air volume.

5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A, except B for T12/HO and T12/Slimline lamp ballasts.

2. Total Harmonic Distortion Rating: Less than 10 percent.

3. Transient Voltage Protection: IEEE C62.41, Category A or better.

4. Operating Frequency: 20 kHz or higher.

5. Lamp Current Crest Factor: 1.7 or less.

6. BF: 0.85 or higher.

7. Power Factor: 0.98 or higher.

8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.

2. Automatic lamp starting after lamp replacement.

3. Sound Rating: A.

4. Total Harmonic Distortion Rating: Less than 20 percent.

5. Transient Voltage Protection: IEEE C62.41, Category A or better.

6. Operating Frequency: 20 kHz or higher.

7. Lamp Current Crest Factor: 1.7 or less.

8. BF: 0.95 or higher, unless otherwise indicated.

9. Power Factor: 0.98 or higher.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

D. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

E. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F and Higher: Electronic type rated for 0 deg F starting and operating temperature with indicated lamp types.

2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.

F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.

2. Ballast Input Watts: Can be reduced to 20 percent of normal.

3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

a. High-Level Operation: 100 percent of rated lamp lumens.

b. Low-Level Operation: 50 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.

3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.

2. Automatic lamp starting after lamp replacement.

3. Sound Rating: A.

4. Total Harmonic Distortion Rating: Less than 20 percent.

5. Transient Voltage Protection: IEEE C62.41, Category A or better.

6. Operating Frequency: 20 kHz or higher.

7. Lamp Current Crest Factor: 1.7 or less.

8. BF: 0.95 or higher, unless otherwise indicated.

9. Power Factor: 0.98 or higher.

10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

11. Ballast Case Temperature: 75 deg C, maximum.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.

2. Ballast Input Watts: Can be reduced to 20 percent of normal.

3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Night-Light Connection: Operate one fluorescent lamp continuously.

3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.

5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Night-Light Connection: Operate one fluorescent lamp in a remote fixture continuously.

3. Battery: Sealed, maintenance-free, nickel-cadmium type.

4. Charger: Fully automatic, solid-state, constant-current type.

5. Housing: NEMA 250, Type 1 enclosure.

6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.

3. Normal Ambient Operating Temperature: 104 deg F.

4. Open-circuit operation that will not reduce average life.

5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Lamp end-of-life detection and shutdown circuit.

2. Sound Rating: A.

3. Total Harmonic Distortion Rating: Less than 15 percent.

4. Transient Voltage Protection: IEEE C62.41, Category A or better.

5. Lamp Current Crest Factor: 1.5 or less.

6. Power Factor: .90 or higher.

7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

8. Protection: Class P thermal cutout.

9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.

10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.

a. High-Level Operation: 100 percent of rated lamp lumens.

b. Low-Level Operation: 50 percent of rated lamp lumens.

c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.

a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.

b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

D. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.

a. Restrike Range: 105- to 130-V ac.

b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2. Minimum Starting Temperature: Minus 40 deg F.

3. Open-circuit operation shall not reduce average lamp life.

2.7 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.

2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.

b. Charger: Fully automatic, solid-state type with sealed transfer relay.

c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

4. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in ballast for power connection to remote unit.

b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.8 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.9 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. T5 rapid-start low-mercury] lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours, unless otherwise indicated.

E. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

F. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).

2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).

3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).

4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).

5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.10 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.

1. Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.

B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.12 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES

A. Comply with UL 1598 listing requirements.

1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.

2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

PART 3 EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

*** END OF SECTION 26 51 00 ***

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