SECTION 23 01 00 - MECHANICAL GENERAL

PART 1 GENERAL

1.01 The work covered by this division consists of providing all labor, equipment and materials and performing all operations necessary for the installation of the mechanical work as herein called for and shown on the drawings.

1.02 Related Documents:

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

B. This is a Basic Mechanical Requirements Section. Provisions of this section apply to work of all Division 21, 22, and 23 sections.

C. Review all other contract documents to be aware of conditions affecting work herein.

D. Definitions:

1. Provide: Furnish and install, complete and ready for intended use.

2. Furnish: Supply and deliver to project site, ready for subsequent requirements.

3. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.

1.03 Permits and Fees: Contractor shall obtain all necessary permits, meters, and inspections required for his work and pay all fees and charges incidental thereto.

1.04 Verification of Owner's Data: Prior to commencing any work the Contractor shall satisfy himself as to the accuracy of all data as indicated in these plans and specifications and/or as provided by the Owner. Should the Contractor discover any inaccuracies, errors, or omissions in the data, he shall immediately notify the Architect/Engineer in order that proper adjustments can be anticipated and ordered. Commencement by the Contractor of any work shall be held as an acceptance of the data by him after which time the Contractor has no claim against the Owner resulting from alleged errors, omissions or inaccuracies of the said data.

1.05 Delivery and Storage of Materials: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. All material shall be stored to provide protection from the weather and accidental damage.

1.06 Extent of work is indicated by the drawings, schedules, and the requirements of the specifications. Singular references shall not be constructed as requiring only one device if multiple devices are shown on the drawings or are required for proper system operation.

1.07 Field Measurements and Coordination:

A. The intent of the drawings and specifications is to obtain a complete and satisfactory installation. Separate divisional drawings and specifications shall not relieve the Contractor or subcontractors from full compliance of work of his trade indicated on any of the drawings or in any section of the specifications.

B. Verify all field dimensions and locations of equipment to insure close, neat fit with other trades' work. Make use of all contract documents and approved shop drawings to verify exact dimension and locations.

C. Coordinate work in this division with all other trades in proper sequence to insure that the total work is completed within contract time schedule and with a minimum cutting and patching.

D. Locate all apparatus symmetrical with architectural elements. Install to exact height and locations when shown on architectural drawings. When locations are shown only on mechanical drawings, be guided by architectural details and conditions existing at job and correlate this work with that of others.

E. Install work as required to fit structure, avoid obstructions, and retain clearance, headroom, openings and passageways. Cut no structural members without written approval.

F. Carefully examine any existing conditions, piping, and premises. Compare drawings with existing conditions. Report any observed discrepancies. It shall be the Contractor's responsibility to properly coordinate the work and to identify problems in a timely manner. Written instructions will be issued to resolve discrepancies.

G. Because of the small scale of the drawings, it is not possible to indicate all offsets and fittings or to locate every accessory. Drawings are essentially diagrammatic. Study carefully the sizes and locations of structural members, wall and partition locations, trusses, and room dimensions and take actual measurements on the job. Locate piping, ductwork, equipment and accessories with sufficient space for installing and servicing. Contractor is responsible for accuracy of his measurements and for coordination with all trades. Contractor shall not order materials or perform work without such verification. No extra compensation will be allowed because field measurements vary from the dimensions on the drawings. If field measurements show that equipment or piping cannot be fitted, the Architect/Engineer shall be consulted. Remove and relocate, without additional compensation, any item that is installed and is later found to encroach on space assigned to another use.

1.08 Guarantee:

A. The Contractor shall guarantee labor, materials and equipment for a period of two (2) years from Final Completion, or from Owner's occupancy, whichever is earlier. Contractor shall make good any defects and shall include all necessary adjustments to and replacement of defective items without expense to the Owner.

B. Owner reserves right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving Contractor of his responsibilities during guarantee period.

C. The contractor shall provide routing maintenance for entire system, including all materials and labor required, during the two (2) year warranty period.

1.09 Approval Submittals:

A. When approved, the submittal control log and submittals shall be an addition to the specifications herewith, and shall be of equal force in that no deviation will be permitted except with the approval of the Architect/Engineer.

1. Shop drawings, product literature, and other approval submittals will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions and Division 1 Specification sections and the following.

2. Submittals shall be properly organized in accordance with the approved submittal control log.

3. Submittals shall not include items from more than one specification section in the same submittal package unless approved in the submittal control log.

4. Submittals shall be properly identified by a cover sheet showing the project name, Architect and Engineer names, submittal control number, specification section, a list of products or item names with model numbers in the order they appear in the package, and spaces for approval stamps. A sample cover sheet is included at the end of this section.

5. Submittals shall have been reviewed and approved by the General Contractor (or Prime Contractor). Evidence of this review and approval shall be an "Approved" stamp with a signature and date on the cover sheet.

6. Submittals that include a series of fixtures or devices (such as plumbing fixtures or valves) shall be organized by the fixture number or valve type and be marked accordingly. Each fixture must include all items associated with that fixture regardless of whether or not those items are used on other fixtures.

7. The electrical design shown on the drawings supports the mechanical equipment basis of design specifications at the time of design. If mechanical equipment is submitted with different electrical requirements, it is the responsibility of the mechanical contractor to resolve all required electrical design changes (wire and conduit size, type of disconnect or overload protection, point(s) of connection, etc.) and clearly show the new electrical design on the mechanical submittal with a written statement that this change will be provided at no additional cost. Mechanical submittals made with no written reference to the electrical design will be presumed to work with the electrical design. Any corrections required will be at no additional cost.

B. If the shop drawings show variation from the requirements of contract because of standard shop practice or other reasons, the Contractor shall make specific mention of such variation in writing in his letter of transmittal and on the submittal cover sheet in order that, if acceptable, Contractor will not be relieved of the responsibility for executing the work in accordance with the contract.

C. Review of shop drawings, product literature, catalog data, or schedules shall not relieve the Contractor from responsibility for deviations from contract drawings or specifications, unless he has in writing called to the attention of the Architect/Engineer each such deviation in writing at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings, product literature, catalog data, or

schedules. Any feature or function specified but not mentioned in the submittal shall be assumed to be included per the specification.

D. Submit shop drawings as called for in other sections after award of the contract and before any material is ordered or fabricated. Shop drawings shall consist of plans, sections, elevations and details to scale (not smaller than ¼" per foot), with dimensions clearly showing the installation. Direct copies of small scale project drawings issued to the Contractor are not acceptable. Drawings shall take into account equipment furnished under other sections and shall show space allotted for it. Include construction details and materials.

1.10 Test Reports and Verification Submittals: Submit test reports, certifications and verification letters as called for in other sections. Contractor shall coordinate the required testing and documentation of system performance such that sufficient time exists to prepare the reports, submit the reports, review the reports and take corrective action within the scheduled contract time.

1.11 O&M Data Submittals: Submit Operation and Maintenance data as called for in other sections. When a copy of approval submittals is included in the O&M Manual, only the final "Approved" or "Approved as Noted" copy shall be used. Contractor shall organize these data in the O&M Manuals tabbed by specification number. Prepare O&M Manuals as required by Division 1 and as described herein.. Submit manuals at the Substantial Completion inspection.

PART 2 PRODUCTS

2.01 All materials shall be new or Owner-supplied reused as shown on the drawings, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following sections.

2.02 Equipment and Materials:

A. Shall be new and the most suitable grade for the purpose intended. Equipment furnished under this division shall be the product of a manufacturer regularly engaged in the manufacture of such items for a period of three years. Where practical, all of the components shall be products of a single manufacturer in order to provide proper coordination and responsibility. Where required, Contractor shall furnish proof of installation of similar units or equipment.

B. Each item of equipment shall bear a name plate showing the manufacturer's name, trade name, model number, serial number, ratings and other information necessary to fully identify it. This plate shall be permanently mounted in a prominent location and shall not be concealed, insulated or painted.

C. The label of the approving agency, such as UL, IBR, ASME, ARI, AMCA, by which a standard has been established for the particular item shall be in full view.

D. The equipment shall be essentially the standard product of a manufacturer regularly engaged in the production of such equipment and shall be a product of the manufacturer's latest design.

E. A service organization with personnel and spare parts shall be available within two hours for each type of equipment furnished.

F. Install in accordance with manufacturer's recommendations. Place in service by a factory trained representative where required.

G. Materials and equipment are specified herein by a single or by multiple manufacturers to indicate quality, material and type of construction desired. Manufacturer's products shown on the drawings have been used as basis for design; it shall be the Contractor's responsibility to ascertain that alternate manufacturer's products, or the particular products of named manufacturers, meet the detailed specifications and that size and arrangement of equipment are suitable for installation.

H. Model Numbers: Catalog numbers and model numbers indicated in the drawings and specifications are used as a guide in the selection of the equipment and are only listed for the contractor's convenience. The contractor shall determine the actual model numbers for ordering materials in accordance with the written description of each item and with the intent of the drawings and specifications.

2.03 Requests for Substitution:

A. Where a particular system, product or material is specified by name, consider it as standard basis for bidding, and base proposal on the particular system, product or material specified.

B. Requests by Contractor for substitution will be considered only when reasonable, timely, fully documented, and qualifying under one or more of the following circumstances.

1. Required product cannot be supplied in time for compliance with Contract time requirements.

2. Required product is not acceptable to governing authority, or determined to be non-compatible, or cannot be properly coordinated, warranted or insured, or has other recognized disability as certified by Contractor.

3. Substantial cost advantage is offered Owner after deducting offsetting disadvantages including delays, additional compensation for redesign, investigation, evaluation and other necessary services and similar considerations.

C. All requests for substitution shall contain a "Comparison Schedule" and clearly and specifically indicate any and all differences or omissions between the product specified as the 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:

Principal of operation.
Materials of construction or finishes.
Thickness of gauge of materials.
Weight of item.
Deleted features or items.
Added features or items.
Changes in other work caused by the substitution.
Performance curves.

If the approved substitution contains differences or omissions not specifically called to the attention of the Architect/Engineer, the Owner reserves the right to require equal or

similar features to be added to the substituted products (or to have the substituted products replaced) at the Contractor's expense.

PART 3 EXECUTION

3.01 Workmanship: All materials and equipment shall be installed and completed in a first-class workmanlike manner and in accordance with the best modern methods and practice. Any materials installed which do not present an orderly and reasonably neat and/or workmanlike appearance, or do not allow adequate space for maintenance, shall be removed and replaced when so directed by the Architect/Engineer.

3.02 Coordination:

A. The Contractor shall be responsible for full coordination of the mechanical systems with shop drawings of the building construction so the proper openings and sleeves or supports are provided for piping, ductwork, or other equipment passing through slabs or walls.

B. Any additional steel supports required for the installation of any mechanical equipment, piping, or ductwork shall be furnished and installed under the section of the specifications requiring the additional supports.

C. It shall be the Contractor's responsibility to see that all equipment such as valves, dampers, filters and such other apparatus or equipment that may require maintenance and operation are made easily accessible, regardless of the diagrammatic location shown on the drawings.

D. All connections to fixtures and equipment shown on the drawings shall be considered diagrammatic unless otherwise indicated by detail. The actual connections shall be made to fully suit the requirements of each case and adequately provide for expansion and servicing.

E. The contractor shall protect equipment, material, and fixtures at all times. He shall replace all equipment, material, and fixtures which are damaged as a result of inadequate protection.

F. Prior to starting and during progress of work, examine work and materials installed by others as they apply to work in this division. Report conditions which will prevent satisfactory installation.

G. Start of work will be construed as acceptance of suitability of work of others.

3.03 Interruption of Service: Before any equipment is shut down for disconnecting or tie-ins, arrangements shall be made with the Architect/Engineer and this work shall be done at the time best suited to the Owner. This will typically be on weekends and/or holidays and/or after normal working hours. Services shall be restored the same day unless prior arrangements are made. All overtime or premium costs associated with this work shall be included in the base bid.

3.04 Phasing: Provide all required temporary valves, piping, ductwork, equipment and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.05 Cutting and Patching: Notify General Contractor to do all cutting and patching of all holes, chases, sleeves, and other openings required for installation of equipment furnished and installed under this section. Utilize experienced trades for cutting and patching. Obtain permission from Architect/Engineer before cutting any structural items.

3.06 Equipment Setting: Bolt equipment directly to concrete pads or vibration isolators as required, using hot-dipped galvanized anchor bolts, nuts and washers. Level equipment.

3.07 Painting: Touch-up factory finishes on equipment located inside and outside shall be done under Division 23. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.

3.08 Clean-up: Thoroughly clean all exposed parts of apparatus and equipment of cement, plaster, and other materials and remove all oil and grease spots. Repaint or touch up as required to look like new. During progress of work, contractor is to carefully clean up and leave premises and all portions of building free from debris and in a clean and safe condition.

3.09 Start-up and Operational Test: Start each item of equipment in strict accordance with the manufacturer's instructions; or where noted under equipment specification, start-up shall be done by a qualified representative of the manufacturer. Alignment, lubrication, safety, and operating control shall be included in start-up check.

3.10 Climate Control: Operate heating and cooling systems as required after initial startup to maintain temperature and humidity conditions to avoid freeze damage and warping or sagging of ceilings and carpet.

3.11 Record Drawings:

A. During the progress of the work the Contractor shall record on their field set of drawings the exact location, as installed, of all piping, ductwork, equipment, and other systems which are not installed exactly as shown on the contract drawings.

B. Upon completion of the work, record drawings shall be prepared as described in the General Conditions, Supplementary Conditions, and Division 1 sections.

3.12 Acceptance:

A. Punch List: Submit written confirmation that all punch lists have been checked and the required work completed.

B. Instructions: At completion of the work, provide a competent and experienced person who is thoroughly familiar with project, for one day to instruct permanent operating personnel in operation of equipment and control systems. This is in addition to any specific equipment operation and maintenance training.

C. Operation and Maintenance Manuals: Furnish four complete manuals bound in ring binders with Table of Contents, organized, and tabbed by specification section. Manuals shall contain:

Detailed operating instructions and instructions for making minor adjustments.
Complete wiring and control diagrams.
Routine maintenance operations.

Manufacturer's catalog data, service instructions, and parts lists for each piece of operating equipment.
Copies of approved submittals.
Copies of all manufacturer's warranties.
Copies of test reports and verification submittals.

D. Record Drawings: Submit record drawings.

E. Test and Balance Report: Submit four certified copies. The Report shall be submitted for review prior to the Substantial Completion Inspection unless otherwise required by Division 1.

F. Acceptance will be made on the basis of tests and inspections of job. A representative of firm that performed test and balance work shall be in attendance to assist. Contractor shall furnish necessary mechanics to operate system, make any necessary adjustments and assist with final inspection.

G. Control Diagrams: Frame under glass and mount on equipment room wall.

END OF SECTION 23 01 00

SECTION 23 05 20 - PIPES AND PIPE FITTINGS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-21, 22, and 23 section making reference to pipes and pipe fittings specified herein.

1.03 Extent of pipes and pipe fittings required by this section is indicated on drawings and/or specified in other Division-21, 22, and 23 sections.

1.04 Codes and Standards:

A. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.

B. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

1.05 Test Report and Verification Submittals:

A. Submit welding certification for all welding installers.

B. Submit brazing certification for all brazing installers.

PART 2 PRODUCTS

2.01 Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

2.02 Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.03 Piping Materials/Products:

A. Soldering Materials:

1. Tin-Antimony (95-5) Solder: ASTM B-32, Grade 95TA.

2. Silver-Phosphorus Solder: ASTM B-32, Grade 96TS.

B. Pipe Thread Tape: Teflon tape.

C. Protective Coating: Koppers Bitumastic No. 505 or equal.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast iron flanges; raised-face for steel flanges, unless otherwise noted.

E. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials. Materials shall be determined by installer to comply with installation requirements.

F. Brazing Materials: Silver content of not less than 15%. Materials shall be determined by installer to comply with installation requirements.

2.04 Copper Tube and Fittings:

A. Copper Tube:

1. Copper Tube: ASTM B88; Type K or L as indicated for each service; hard-drawn temper unless specifically noted as annealed.

2. ACR Copper Tube: ASTM B280.

3. DWV Copper Tube: ASTM B306.

B. Fittings:

1. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.

2. Copper Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

3. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.

4. Cast-Copper Flared Tube Fittings: ANSI B16.26.

2.05 Steel Pipes and Pipe Fittings

A. Pipes:

1. Black Steel Pipe: ASTM A-53 or A-120, seamless.

2. Galvanized Steel Pipe: ASTM A-53 or A-120, seamless.

B. Pipe Fittings:

2. Threaded Cast Iron: ANSI B16.4.

3. Threaded Malleable Iron: ANSI B16.3; plain or galvanized as indicated.

4. Malleable Iron Threaded Unions: ANSI B16.39; selected by installer for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.

5. Threaded Pipe Plugs: ANSI B16.14.

6. Flanged Cast Iron: ANSI B16.1, including bolting.

7. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing.

8. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns, rated to match connected pipe.

9. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than schedule 80 pipe where length remaining unthreaded is less than 1 ½ inches, and where pipe size is less than 1 ½ inches, and do not thread nipples full length (no close-nipples).

2.06 Plastic Pipes and Fittings:

A. Pipes:

1. PVC DWV Pipe: ASTM D-2665, Schedule 40.

2. PVC Sewer Pipe: ASTM D-3034.

B. Fittings:

1. PVC Solvent Cement: ASTM D-2564.

2. PVC DWV Socket: ASTM D-2665.

3. PVC Sewer Socket: ASTM D-3034.

PART 3 EXECUTION

3.01 Installation

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leak proof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings, not bushings. Align piping accurately at connections, within 1/16" misalignment tolerance.

B. Comply with ANSI B31 Code for Pressure Piping.

C. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to ½" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation.

D. Concealed Piping: Unless specifically noted as “Exposed” on the drawings, conceal piping from view in finished and occupied spaces, by locating in column enclosures, chases, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

E. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical, communications, or data equipment spaces and enclosures unless shown. Install drip pan under piping that must run through electrical spaces.

1. Cut pipe from measurements taken at the site, not from drawings. Keep pipes free of contact with building construction and installed work.

3.02 Piping System Joints: Provide joints of the type indicated in each piping system.

A. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply non-acid type solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed. Paint exposed threads to retard rusting.

C. Flanged Joints: Match flanges within piping system, and at connection with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets. Bolts shall project 1/8" to 3/8" beyond nut face when tight.

D. Weld pipe joints in accordance with recognized industry practice and as follows. Be guided by ANSI B.31.

1. Weld pipe joints only when ambient temperature is above 0°F.

2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.

3. Use pipe clamps or tack-weld joints; 4 welds for pipe sizes to 10". All welds shall be open-butt.

4. Build up welds with root pass, followed by filler pass and then a cover pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.

5. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

6. At Installer's option, install forged branch-connection fittings wherever branch pipe is less than 3" and at least two pipe sizes smaller than main pipe indicated; or install regular "T" fitting. Weld-O-Let or equal.

E. Plastic Pipe Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards.

1. Solvent-cemented joints shall be made in accordance with ASTM D-2235 and ASTM F-402.

2. PVC sewer pipe bell/gasket joints shall be installed in accordance with ASTM D-2321.

F. Braze copper tube-and-fitting joints where indicated, in accordance with ANSI B.31.

3.03 Piping Installation

A. Install piping to allow for expansion and contraction.

B. Isolate all copper tubing from steel and concrete by wrapping the pipe at the contact point, and for one inch on each side, with a continuous plastic sleeve. Isolate all copper tubing installed in block walls with a continuous plastic sleeve.

C. Underground Piping:

1. Provide plastic tape markers over all underground piping. Provide copper wire over all underground plastic piping. Locate markers 18" above piping.

2. Coat the following underground (uninsulated) pipes with a heavy coat of bitumastic or provide an 8 mil polyvinyl sleeve: black steel pipe, galvanized steel pipe, copper tubing.

END OF SECTION 23 05 20

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SECTION 23 05 21 - PIPING SPECIALTIES

PART 1 GENERAL

1.01 Drawings and general provisions of contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-21, 22 and 23 section making reference to or requiring piping specialties specified herein.

PART 2 PRODUCTS

2.01 General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

2.02 Escutcheons:

A. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

B. Pipe Escutcheons: Provide cast brass or sheet brass escutcheons, solid or split hinged.

2.03 Dielectric Unions: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action and stop corrosion. .

2.04 Fire Barrier Penetration Seals:

A. Provide seals for any opening through fire-rated walls, floors, or ceilings used as passage for mechanical components such as piping or ductwork in accordance with the requirements of Division 7.

2.05 Fabricated Piping Specialties:

A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over ¼" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.

B. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6" 16 gage; over 6", 14 gage.

2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.

C. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:

1. Caulking and Sealant: Provide foam or caulking and sealant compatible with piping materials used.

PART 3 EXECUTION

3.01 Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

3.02 Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

3.03 Fire Barrier Penetration Seals: Provide pipe sleeve as required. Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions. Refer to Division 7.

3.04 Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

3.05 Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves ¼" above level floor finish, and ¾" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

A. Install sleeves in fire-rated assemblies in accordance with the listing of the assembly and the fire barrier sealant.

B. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings. Fill annular space with caulking or fire barrier sealant as required.

C. Install steel-pipe sleeves at floor penetrations. Fill annular space with caulking or fire barrier sealant as required.

D. Install iron-pipe sleeves at all foundation wall penetrations and at exterior penetrations; both above and below grade. Fill annular space with caulking or mechanical sleeve seals.

END OF SECTION 23 05 21

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SECTION 23 05 23 - VALVES

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

1.02 This section is a Division-23 Basic Materials and Methods section, and is part of each Division-21, 22, and 23 section making reference to or requiring valves specified herein.

1.03 Extent of valves required by this section is indicated on drawings and/or specified in other Division-21, 22, and 23 sections.

1.04 Quality Assurance:

A. Valve Dimensions: For face-to-face and end-to-end dimensions of flanged or welding-end valve bodies, comply with ANSI B16.10.

B. Valve Types: Provide valves of same type by same manufacturer.

C. Valve Listing: For valves on fire protection piping, provide UL listing.

1.05 Approval Submittals: When required by other Division-23 sections, submit product data, catalog cuts, specifications, and dimensioned drawings for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valves with Division-23 section using the valves, not as a separate submittal.

A. Gate Valves. Type GA.

B. Check Valves. Type CK.

C. Ball Valves. Type BA.

1.06 O&M Data Submittals: Submit a copy of approval submittals. Submit installation instructions, maintenance data and spare parts lists for each type of valve. Include this data in the O&M Manual.

PART 2 PRODUCTS

2.01 General: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with specifications and installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube, and equipment connections.

2.02 Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the producers listed for each valve type. The model numbers are listed for contractor's

convenience only. In the case of a model number discrepancy, the written description shall govern.

2.03 Gate Valves:

A. Packing: Select valves designed for repacking under pressure when fully opened, equipped with non-asbestos packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened, and equipped with gland follower.

B. Comply with the following standards:

Cast Iron Valves: MSS SP-70. Cast Iron Gate Valves, Flanged and Threaded Ends.
Bronze Valves: MSS SP-80. Bronze Gate, Globe, Angle and Check Valves.
Steel Valves: ANSI B16.34. Steel Standard Class Valve Ratings.

C. Types of gate (GA) valves:

1. Threaded Ends 2" and Smaller (GA1): Class 125, bronze body, screwed bonnet, rising stem, solid wedge. Stockham B-100. Nibco T-111. Crane 428. Milwaukee 148.

2. Soldered Ends 2" and Smaller (GA2): Class 125, bronze body, screwed bonnet, non-rising stem, solid wedge. Stockham B-108 or B-109. Nibco S-111. Crane 1334. Milwaukee 149.

3. Flanged Ends 2½" and Larger (GA3): Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge. Stockham G-623. Nibco F617-0. Crane 465½. Milwaukee F2885.

4. Threaded Ends 2" and Smaller (GA4): Class 150, bronze body, screwed bonnet, rising stem, solid wedge. Stockham B-122. Nibco T-131. Crane 431. Milwaukee 1150.

5. Soldered Ends 2" and Smaller (GA5): Class 150, bronze body, screwed bonnet, rising stem, solid wedge. Stockham B-124. Nibco S-134. Milwaukee 1169.

6. Threaded Ends 2" and Smaller (GA6): 175 WWP, bronze body, screwed bonnet, rising stem, OS&Y, solid wedge, UL-listed. Stockham B-133. Nibco T-104-0.

7. Flanged Ends 2½" and Larger (GA7): 175 WWP, iron body, bolted bonnet, rising stem, OS&Y, solid wedge, UL listed. Stockham G-634. Nibco F-607-0TS

8. Threaded Ends 2" and Smaller (GA8): Class 200, bronze body, union bonnet, rising stem, solid wedge, renewable seat. Stockham B-132. Nibco T-154-SS. Milwaukee 1174.

9. Flanged Ends 2½" and Larger (GA9): Class 250, iron body bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge. Stockham F-667. Nibco F-667-0. Crane 7½E. Milwaukee F-2894.

10. Threaded Ends 2" and Smaller (GA10): Class 300, bronze body, union bonnet, rising stem, solid wedge, renewable seat. Stockham B-145. Nibco T-174-SS. Crane 634E. Milwaukee 1184.

11. Flanged Ends 2½" and Larger (GA11): Class 300, cast steel body, bolted bonnet, rising stem, solid wedge, seal-welded seat rings. Provide trim to match use. Stockham 30-0F. Crane 33.

12. Flanged Ends 2½" and Larger (GA12): 300 WWP, iron body, bolted bonnet, bronze mounted, rising stem, OS&Y, solid wedge, UL-listed. Stockham F-670. Nibco F-697-0.

2.04 Ball Valves:

A. General: Select with port area equal to or greater than connecting pipe area, include seat ring designed to hold sealing material.

B. Construction: Ball valves shall be rated for 150 psi saturated steam and 600 psi non-shock cold water. Pressure containing parts shall be constructed of ASTM B-584 alloy 844, or ASTM B-124 alloy 377. Valves shall be furnished with blow-out proof bottom loaded stem constructed of ASTM B-371 alloy 694 or other approved low zinc material. Provide TFE packing, TFE thrust washer, chrome-plated ball and reinforced teflon seats. Valves 1" and smaller shall be full port design. Valves 1¼" and larger shall be conventional port design. Stem extensions shall be furnished for use in insulated piping where insulation exceeds ½" thickness.

C. Comply with the following standards:

MSS SP-72. Ball Valves with Flanged or Butt Welding Ends for General Service.
MSS SP-110. Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

D. Types of ball (BA) valves:

1. Threaded Ends 2" and Smaller (BA1): Bronze two-piece full port body with adjustable stem packing. Nibco T-585-70. Stockham S216-BR-R-T. Milwaukee BA125. Apollo 77-100.

2. Soldered Ends 2" and Smaller (BA2): Bronze three-piece full port body with adjustable stem packing. Nibco S-595-Y-66. Milwaukee BA350. Apollo 82-200.

3. Threaded Ends 1" and Smaller (BA3): Bronze two-piece full port body, UL listed (UL 842) for use with flammable liquids and LP gas. Nibco T-585-70-UL.

4. Threaded Ends 2" and Smaller (BA4): 175 WWP, bronze two-piece body, UL listed for fire protection service. Nibco KT-585-70-UL and KT-580-70-UL.

5. Threaded Ends 2" and Smaller (BA5): 400 WWP, bronze two-piece body, for fire protection service. Nibco KT-580.

6. Threaded Ends 2½" and Smaller (BA6): 300 WWP, bronze three-piece body, gear operator with handwheel, indicator flag, accepts tamper switch, for fire protection, UL listed. Nibco T-505-4 and G-505-4.

7. Flanged Ends 2½" and Larger (BA7): Class 150, carbon steel full bore two-piece body with adjustable stem packing. Nibco F515-CS series. Apollo 88-240.

2.05 Valve Features:

A. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ANSI B31.1

B. Valve features specified or required shall comply with the following:

1. Bypass: Comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving. Provide for gate valves 8" and larger.

2. Drain: Comply with MSS SP-45, and provide threaded pipe plugs complying with applicable Division-23 pipe or tube section. Provide for gate valves 8" and larger.

3. Flanged: Provide valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

4. Threaded: Provide valve ends complying with ANSI B2.1.

5. Solder-Joint: Provide valve ends complying with ANSI B16.18.

6. Trim: Fabricate pressure-containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing industry unless otherwise specified.

7. Non-Metallic Disc: Provide non-metallic material selected for service indicated in accordance with manufacturer's published literature.

8. Renewable Seat: Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.

9. Extended Stem: Increase stem length by 2" minimum, to accommodate insulation applied over valve.

10. Mechanical Actuator: Provide factory-fabricated gears, gear enclosure, external chain attachment and chain designed to provide mechanical advantage in operating valve for all valves 4" and larger that are mounted more than 7'-0" above the floor, or are otherwise difficult to operate regardless of height.

PART 3 EXECUTION

3.01 Installation:

A. General: Install valves where required for proper operation of piping and equipment, including valves in branch lines to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward below horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator.

D. Mechanical Actuators: Install mechanical actuators as recommended by valve manufacturer.

3.02 Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections:

A Tube Size 2" and Smaller: Threaded valves.

B Pipe Size 2" and Smaller: Threaded valves.

C Pipe Size 2½" and Larger: Flanged valves.

3.03 Non-Metallic Disc: Limit selection and installation of valves with non-metallic disc to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

3.04 Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

END OF SECTION 23 05 23

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SECTION 23 05 29 - SUPPORTS, ANCHORS, AND SEALS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Materials and Methods section, and is a part of each Division-21, 22, and 23 section making reference to or requiring supports, anchors, and seals specified herein.

1.03 Extent of supports, anchors, and seals required by this section is indicated on drawings and/or specified in other Division-21, 22, and 23 sections.

1.04 Code Compliance: Comply with applicable codes pertaining to product materials and installation of supports, anchors, and seals.

1.05 MSS Standard Compliance:

A. Provide pipe hangers and supports of which materials, design, and manufacture comply with ANSI/MSS SP-58.

B. Select and apply pipe hangers and supports, complying with MSS SP-69.

C. Fabricate and install pipe hangers and supports, complying with MSS SP-89.

D. Terminology used in this section is defined in MSS SP-90.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers: Subject to compliance with requirements, provide supports and hangers by Grinnel, Michigan Hanger Company, B-Line Systems, or approved equal.

2.02 Horizontal-Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.

A. Adjustable Steel Clevises: MSS Type 1.

B. Steel Double Bolt Pipe Clamps: MSS Type 3.

C. Adjustable Steel Band Hangers: MSS Type 7.

D. Steel Pipe Clamps: MSS Type 4.

E. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

F. Single Pipe Rolls: MSS Type 41.

G. Adjustable Roller Hanger: MSS Type 43.

H. Pipe Roll Stands: MSS Type 44 or Type 47.

2.03 Vertical-Piping Clamps: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

A. Two-Bolt Riser Clamps: MSS Type 8.

B. Four-Bolt Riser Clamps: MSS Type 42.

2.04 Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

A. Steel Turnbuckles: MSS Type 13.

B. Malleable Iron Sockets: MSS Type 16.

2.05 Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.

A. Center Beam Clamps: MSS Type 21.

B. C-Clamps: MSS Type 23.

C. Malleable Beam Clamps: MSS Type 30.

D. Side Beam Brackets: MSS Type 34.

E. Concrete Inserts: MSS Type 18.

2.06 Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

A. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

B. Protection Saddles: MSS Type 39; use with rollers, fill interior voids with segments of insulation matching adjoining insulation.

2.07 Miscellaneous Materials:

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ANSI/ASTM A 36.

C. Cement Grout: Portland cement (ANSI/ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ANSI/ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes or continuous channel struts selected for loads required; weld steel in accordance with AWS standards.

PART 3 EXECUTION

3.01 Preparation

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, and installers of other work requiring coordination with work of this section for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.02 Installation of Building Attachments:

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

B. In areas of work requiring attachments to existing concrete, use self drilling rod inserts, Phillips Drill Co., "Red-Head" or equal.

3.03 Installation of Hangers and Supports:

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69 or as listed herein, whichever is most limiting. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for

smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

1. Horizontal steel pipe and copper tube 1-1/4" diameter and smaller: support on 6 foot centers.

2. Horizontal steel pipe and copper tube 1-1/2" diameter and larger: support on 10 foot centers.

3. Vertical steel pipe and copper tube: support at each floor.

4. Plastic pipe: support in accordance with manufacturer's recommendations.
5. Fire protection piping: support in accordance with NFPA 13.

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

C. Paint all black steel hangers with black enamel. Galvanized steel and copper clad hangers do not require paint.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

E. Provision for Movement:

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

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

3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

F. Insulated Piping: Comply with the following installation requirements.

1. Shields: Where low-compressive-strength insulation or vapor barriers are indicated, install coated protective shields.

2. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

G. Support fire protection piping independently of other piping.

3.04 Installation of Anchors:

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

C. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and elbows. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

D. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

3.05 Equipment Bases:

A. Provide concrete housekeeping bases where indicated for all floor mounted equipment furnished as part of the work of Division 23. Size bases to extend minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

3.06 Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands. Prime and paint with black enamel.

END OF SECTION 23 05 29

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SECTION 23 05 48 - VIBRATION ISOLATION

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-23 section making reference to vibration isolation equipment.

1.03 Extent of vibration isolation required by this section is indicated on drawings and/or specified in other Division-23 sections.

1.04 Approval Submittals: When required by other Division-23 sections, submit product data sheets for each type of vibration isolation equipment including configuration and rating data. Submit with Division-23 section using vibration isolation, not as a separate submittal. Provide calculations showing supported weight, deflection, and isolator size and type for each item of supported equipment. Submit for:

A. Equipment Mountings. Type EM.
B. Hangers. Type HA.

1.05 O&M Data Submittals: Submit a copy of approval submittals for each type of vibration isolation equipment. Include this data in O&M Manual.

PART 2 PRODUCTS

2.01 General: Provide factory-fabricated products recommended by manufacturer for use in service indicated. Provide products of types and deflections indicated; provide proper selection as determined by Installer to comply with specifications and installation requirements. Provide sizes which properly fit with equipment. All metal parts installed outside shall be hot dipped galvanized after fabrication.

2.02 Acceptable Manufacturers: Subject to compliance with requirements, provide vibration isolation equipment of: Mason Industries, Keflex, Consolidated Kinetics, Vibration Mountings & Controls, Wheatley or approved equal. All vibration isolators shall be supplied by a single approved manufacturer.

2.03 Equipment Mountings:

A. Select mountings with the required deflection and fastening means. Provide steel rails or bases as required to compensate for equipment rigidity and overhang.

B. Types of equipment mountings (EM):

1. Spring Mountings (EM1): Spring isolators shall be free-standing and laterally stable without any housing. All mounts shall have leveling bolts. Spring diameter shall be not less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated

deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one. Provide a nominal static deflection of at least 1.0". Basis of Design: Mason Industries SLFH.

2. Spring Mountings with Housings (EM2): Spring isolators shall consist of open, stable steel springs and include vertical travel limit stops to control extension when weight is removed. The housing of the spring unit shall serve as blocking during erection of equipment. Provide a nominal static deflection of at least 1.0". All mountings used outside shall be hot dipped galvanized. Basis of Design: Mason Industries SLR.

3. Spring Mountings with Housings (EM3): Spring isolators shall consist of open, stable steel springs with neoprene inserts to limit movement between upper and lower housing on start and stop. Provide a nominal static deflection of at least 1.0". Mountings shall be specifically designed for critical areas on light-weight floors. Basis of Design: Mason Industries C.

4. Neoprene Mountings (EM4): Double deflection neoprene-in-shear mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered. The top and bottom surfaces shall be neoprene ribbed and bolt holes shall be provided in the base. Basis of design: Mason Industries ND.

5. Pads (EM5): Waffle or ribbed pattern neoprene pads shall be fabricated from 40-50 durometer neoprene. Provide rigid steel plate and mounting angles as required. Basis of design: Mason Industries Super W.

2.04 Hangers:

A. Select hangers with the required deflection. Provide all required hanger rods and fasteners.

B. Types of hangers (HA):

1. Hangers (HA1): Vibration hangers shall contain a steel spring set in a neoprene cup manufactured with a grommet to prevent short-circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower-hole sizes shall be large enough to permit the hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Basis of Design: Mason Industries 30.

2. Hangers (HA2): Vibration hangers shall contain a laterally stable steel spring and 0.3" deflection neoprene or fiberglass element in series. A neoprene neck shall be provided where the hanger rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Basis of Design: Mason Industries 30N.

3. Hangers (HA3): Double deflection neoprene-in-sheer or EPDM hangers. Units shall be complete with projected neoprene bushing to prevent steel-to-steel contact between hanger box and hanger rod. Average static deflection shall be not less than

0.4 inches. Basis of Design: Mason Industries HD.

PART 3 EXECUTION

3.01 Install vibration isolation devices for the duty indicated and for ease of inspection, adjustment, and proper operation. Install in accordance with the manufacturer's written instructions and coordinate with shop drawings of supported equipment.

3.02 All connections to fixtures and equipment shown on the drawings shall be considered diagrammatic unless otherwise indicated by detail. The actual connections shall be made to fully suit the requirements of each case and adequately provide for expansion and servicing.

3.03 Piping, ductwork and conduit shall not be suspended from one another or physically contact one another. Vibrating systems shall be kept free from non-vibrating systems.

3.04 Equipment Mountings:

A. Unless otherwise shown or specified, all floor-mounted equipment shall be set on housekeeping equipment bases. Refer to Division-23 section “Supports, Anchors, and Seals”.

B. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators, and such direct support is approved by the equipment manufacturer. All support frames shall be sufficiently stiff and rigid so as to prevent distortion and misalignment of components installed thereon.

C. Align equipment mountings for a free, plumb installation. Isolators that are binding, offset or fully compressed will not be accepted.

3.05 Hangers:

A Position vibration isolation hangers so that hanger housing may rotate a full 360 degrees without contacting any object.

B Install steel angles, channels, rods and fasteners to level equipment, piping or ductwork and to evenly distribute the supported weight.

3.06 Connections of Ducts: Ducts shall be connected to fan intakes and discharges by means of flexible connectors in accordance with Division-23 section "Ductwork Accessories" so that all vibrating equipment is fully isolated.

END OF SECTION 23 05 48

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SECTION 23 05 53 - MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-22 and 23 section making reference to or requiring identification devices specified herein.

1.03 Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division-22 and 23 sections.

1.04 Refer to Division-26 sections for identification requirements of electrical work; not work of this section. Refer to other Division-23 sections for identification requirements for controls; not work of this section.

1.05 Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 PRODUCTS

2.01 General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.02 Painted Identification Materials

A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 1-¼" high letters for ductwork and not less than ¾" high letters for access door signs and similar operational instructions.

B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Standard identification enamel.

2.03 Plastic Pipe Markers

A. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers.

1. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as shown or specified.

2. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.04 Valve Tags:

A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in ¼" high letters and sequenced valve numbers ½" high, and with 5/32" hole for fastener. Provide 1-½" diameter tags, except as otherwise indicated.

B. Plastic Laminate Valve Tags: Provide manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in ¼" high letters and sequenced valve numbers ½" high, and with 5/32" hole for fastener. Provide 1-½" square black tags with white lettering, except as otherwise indicated.

2.05 Engraved Plastic-Laminate Signs:

A. General: Provide engraving stock melamine plastic laminate, in the sizes and thicknesses indicated, engraved with engraver's standard letter style a minimum of 3/4" tall and wording indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8” for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.06 Stamped Nameplates: Provide equipment manufacturer's standard stamped nameplates for motors, AHUs, pumps, etc.

PART 3 EXECUTION

3.01 Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 Ductwork Identification:

A. General: Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow, in black or white.

B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures, and at 50' spacings along exposed runs.

C. Access Doors: Provide stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate and procedural information.

3.03 Piping System Identification:

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe markers.

2. Stenciled markers, black or white for best contrast.

B. Locate pipe markers as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces and exterior non-concealed locations.

1. Near each valve and control device.

2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

3. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.

4. At access doors, manholes and similar access points which permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.

7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. The following piping shall be color-coded where exposed in mechanical and electrical rooms by completely painting the piping with the indicated color. Use standard colors where exposed in finished spaces. Use standard identification methods in concealed areas.

Gas piping - Yellow

3.04 Valve Identification: Provide coded valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. Coordinate code with operating instructions.

3.05 Valve Charts: Provide framed, glass covered valve charts in each mechanical room. Identify coded valve number, valve function, and valve location for each valve.

3.06 Mechanical Equipment Identification: Install engraved plastic laminate sign on a vertical surface on or near each major item of mechanical equipment and each operational device. Label shall indicate type of system and area served. Provide signs for the following general categories of equipment and operational devices:

A. Main control and operating valves, including safety devices.

B. Meters, gauges, thermometers and similar units.

C. Water Heaters, Furnaces, and Heaters.

D. Pumps.

E. Fans.

F. HVAC air handlers and fan coil units.

G. Air conditioning indoor and outdoor units.

3.07 Stamped Nameplates: Equipment manufacturers to provide standard stamped nameplates on all major equipment items such as motors, pumps, AHUs, etc. Where motors are hidden from view (within equipment casing, or otherwise not easily accessible, etc.), the equipment supplier shall furnish a duplicate motor data nameplate to be affixed to the equipment casing in an easily visible location, unless data is already included on the equipment nameplate.]

3.08 Adjusting and Cleaning:

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 23 05 53

SECTION 23 05 56 - ACCESS DOORS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-22 and 23 section making reference to or requiring access panels specified herein.

1.03 Approval Submittals:

A. Product Data: When required by other Division-22 and 23 sections, submit product data for access doors. Submit with Division-23 section using access doors, not as a separate submittal. Include rating data.

1.04 O&M Data Submittals: Submit a copy of approval submittal. Include this data in O&M Manuals.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers: Subject to compliance with requirements, provide access doors by Acudor, Milcor, Jay R. Smith, Zurn, BOICO, Elmdor, or approved equal.

2.02 General: Where floors, walls and ceilings must be penetrated for access to mechanical work, provide types of access doors indicated. Furnish sizes indicated or, where not otherwise indicated, furnish adequate size for intended and necessary access. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

2.03 Access Door Construction: Except as otherwise indicated, fabricate wall/ceiling door units of welded steel construction with welds ground smooth; 16-gauge frames and 14-gauge flush panel doors; 175° swing with concealed spring hinges; flush screw-driver-operated cam locks; factory-applied rust-inhibitive prime-coat paint finish.

PART 3 EXECUTION

3.01 Access doors shall be installed to operate and service all mechanical equipment including valves, dampers, duct access panels, and other items requiring maintenance that are concealed above or behind finished construction. Access doors shall be installed in walls, chase and floors as necessary, but are not required in accessible suspended ceiling systems. Access doors shall have factory applied protective phosphate coating and baked enamel primer suitable for field painting.

3.02 Access doors shall be installed by the Division installing the substrate construction. However, responsibility for furnishing and determining location of access doors is part of this Division's work. The style of access door shall be suitable for construction into which installed.

3.03 Access doors shall be sized and located as required to provide proper maintenance and service access in accordance with the manufacturer's recommendations and code authority requirements for all devices and equipment.

END OF SECTION 23 05 56

SECTION 23 05 73 - EXCAVATION & BACKFILL

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-23 and Division -22 section making reference to or requiring excavation and backfill specified herein.

1.03 Refer to other Division-22 and 23 sections and/or drawings for specific requirements of the particular piping system being installed. Where another Division-22 or 23 section or the drawings conflict with requirements of this section, the other Division-22 or 23 section or the drawings shall take precedence over the general requirements herein.

1.04 OSHA: Contractor employee worker protection for all trenching and excavation operations shall comply with 29 CFR 1926.650 Subpart P and all current OSHA requirements.

1.05 Trench Safety Act: Contractor shall comply with all requirements of Florida Statutes Chapter 553, including the requirement to provide a separate line item to identify the cost to comply on a per lineal foot of trench and per square foot of shoring.

PART 2 PRODUCTS

2.01 Sand: Clean, hard, uncoated grains free from organic matter or other deleterious substances. Sand for backfill shall be of a grade equal to mortar sand.

2.02 Gravel: Clean, well graded hard stone or gravel, free from organic material. Size range to be from No. 4 screen retentions to 1".

2.03 Earth: Fill free of clay, muck, stones, wood, roots or rubbish.

2.04 Identification Tape: Polyethylene 6 inches wide, 0.004 inches thick, continuously printed with "CAUTION" in large letters and type of pipe below.

2.05 Copper Identification Wire: 14-gauge.

PART 3 EXECUTION

3.01 Ditching and Excavation: Shall be performed by hand wherever there is a possibility of encountering obstacles or any existing utility lines of any nature whatsoever. Where clear and unobstructed areas are to be excavated, appropriate machine excavation methods may be employed. Avoid use of machine excavators within the limits of the building lines.

3.02 Bedding: Excavate to bottom grade of pipe to be installed, and shape bed of undisturbed earth to contour of pipe for a width of at least 50% of pipe diameter. If earth conditions necessitate excavation below grade of the pipe, such as due to the presence of clay, muck, or roots, subcut and bring bed up to proper elevation with clean, new sand (as described in paragraph 2.1),

deposited in 6" layers and tamped. Notify Architect/Engineer if subcut exceeds 12", or if bed is of an unstable nature. In this case a 6" minimum layer of gravel will be required before sand bedding begins. Submit cost proposal if the earth conditions require subcut in excess of 12" or if gravel is required to achieve proper bedding.

3.03 Placing: Pipe shall be carefully handled into place. Avoid knocking loose soil from the banks of the trench into the pipe bed. Rig heavier sections with nylon slings in lieu of wire rope to avoid crushing or chipping. Pipe which is handled with insulation in place, coated pipe, and jacketed pipe shall have special handling slings as required to prevent damage to the material.

3.04 Backfilling: Deposit clean new sand (as described in paragraph 2.1) to 6" above the pipe and tamp. Then deposit sand or earth carefully in 6" layers, maintaining adequate side support, especially on nonferrous piping materials. Compact fill in 6" layers, using mechanical means, up to the top elevation of the pipe, and in 12" layers to rough or finish grade as required. Fine grade and restore surface to original condition.

3.05 Special: Excavations shall be installed and maintained in satisfactory condition during the progress of the work. Subsurface structures are to be constructed in adequately sized excavations. De-watering equipment shall be installed and properly maintained where required. Shoring shall be employed in the event of unstable soil condition, and in all cases where required by OSHA regulations and necessary to protect materials and personnel from injury.

3.06 Identification: Install identification tape directly above all underground piping, one tape for each pipe where multiple pipes are installed. Depth of tape shall be at least 6 inches below finished grade and 24" above buried pipe. Install copper wire above non-metallic pipes.

3.07 Depth of Cover: Minimum cover for underground piping is two feet unless indicated otherwise.

END OF SECTION 23 05 73

SECTION 23 05 90 - START-UP REQUIREMENTS FOR HVAC SYSTEMS

PART 1 GENERAL

1.01 Intent: It is the intent of this section to require that the startup requirements and report noted herein be performed prior to starting TAB work on each system. Work can be phased with permission of the Engineer.

1.02 Coordination:

A. The Contractor shall furnish to the TAB Contractor a complete set of plans, specifications, addenda, shop drawings, equipment performance data sheets, change orders, etc. as requested by the TAB Contractor.

B. The Contractor shall participate in a TAB coordination meeting to discuss interface requirements with the TAB Contractor and to establish a schedule for TAB work prior to start of TAB work.

1.03 Test Reports and Verification Submittals:

A. Submit Startup Report as described herein for each system. Attach Factory Startup Report for equipment as required by other Division-23 sections.

PART 2 PRODUCTS: None

PART 3 EXECUTION:

3.01 The TAB work shall not commence until the Engineer has received written notice from the Contractor that HVAC systems are 100% complete and are fully operational. Submit Startup Report as described herein.

3.02 The Contractor shall place all HVAC systems and equipment into complete operation during each working day of TAB work.

3.03 The Contractor shall provide access to HVAC systems and equipment by supplying ladders and/or scaffolding, and opening access panels and equipment room doors.

3.04 The TAB Contractor will provide to the Contractor TAB punch lists of non-complying HVAC work as they are discovered. The Contractor shall replace or repair non-complying work as soon as possible in order not to delay completion of TAB work.

3.05 Airside Systems: The Contractor shall provide the following information to the Engineer to substantiate proper start-up and preliminary adjustments of air handler units, belt driven fans, and duct systems.

A. Verify that air grilles (supply, return, exhaust, transfer, outdoor, etc.) are installed and connected to the duct system.

B. Verify that duct systems are clean of debris.

C. Verify that ducts attached with flexible connectors are aligned within ½" and have a uniform gap between ducts of 1"-1.5". Flexible connectors shall not leak and shall be insulated.

D. Verify that filters are clean and filter spacers are installed.

E. Verify that balancing dampers at grilles and branch ducts are operational and are fully opened.

F. Verify that fan discharges are appropriate for the outlet ductwork with regards to the "system effect" per AMCA Publication 201. Inappropriate fan discharges will not be accepted.

G. Verify proper fan rotation.

H. Verify proper belt drive alignment.

I. Verify fan motor overload elements are correctly sized.

J. Adjust fan sheave until CFM is at or above design CFM. Provide additional sheaves and belts as required. Verify that motor is not overloaded.

K. Verify that HVAC control systems are fully operational.

3.06 Startup Report: The Contractor shall submit the startup information required by this section to the Engineer in a typed report organized as outlined herein. The Startup Report is required to meet the written notice described herein prior to starting TAB work. TAB work will not start until the Startup Report has been submitted and approved.

END OF SECTION 23 05 90

SECTION 23 05 91 - TESTING, CLEANING, AND STERILIZATION OF PIPING SYSTEMS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 This section is a Division-23 Basic Mechanical Materials and Methods section, and is part of each Division-21, 22, and 23 section making reference to or requiring the testing and other procedures specified herein.

1.03 Notify the Architect/Engineer when system tests are ready to be witnessed at least 24 hours prior to the test.

1.04 All materials, test equipment, and devices required for cleaning, testing, sterilizing or purging shall be provided by the Contractor.

PART 2 PRESSURE TESTS

2.01 General: Provide temporary equipment for testing, including pump and gauges. Test piping systems before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with indicated medium and pressurize for indicated pressure and time.

2.02 Required test period is four hours.

2.03 No piping, fixtures, or equipment shall be concealed or covered until they have been tested. The contractor shall apply each test and ensure that it is satisfactory for the period specified before calling the Architect/Engineer to observe the test. Test shall be repeated upon request to the satisfaction of those making the inspection.

2.04 Observe each test section for leakage at the end of the test period. Test fails if leakage is observed or if pressure drop exceeds 5% of the test pressure.

2.05 Check of systems during application of test pressures should include visual check for water leakage and soap bubble or similar check for air and nitrogen leakage.

2.06 During heating and cooling cycles, linear expansion shall be checked at all elbows and expansion joints for proper clearance.

2.07 Repair piping systems sections which fail required piping test. Disassemble and re-install using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

2.08 Pressure Test Requirements:

A. Soil, Waste, and Vent Test all piping within the building with a 10 foot head of water. Test piping in sections so that all joints are tested. Provide test tees as required.

B. Gas: Test with air or nitrogen at 150% of normal working pressure, but not less than 25 psig. The test and check for leaks shall be in accordance with NFPA-54.

C. Domestic Water: Perform hydrostatic test on all piping within the building at twice the normal static pressure at service point, but not less than 100 psig. Once tested, flush out piping and leave under pressure of the supply main or 40 psig for the balance of the construction period.

D. Fire Sprinkler System: Perform hydrostatic test at 200 psig

PART 3 CLEANING AND STERILIZATION

3.01 General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water or blowdown with air before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

3.02 Flush and drain all water systems at least three times. Reverse flush systems from smallest piping to largest piping. Replace startup strainers with operating strainers.

3.03 Blowdown all systems with air or nitrogen (at a rate of flow exceeding design) at least three times or until no residue shows at each outlet. Reverse blowdown systems from smallest piping to largest piping.

3.04 Sterilization of Domestic Water Systems:

A. Prerequisites: All new hot and cold water piping installed (complete), all fixtures connected, system flushed out, and system filled with water.

B. The shut off valve at the point of connection shall be closed, all fixture outlets opened slightly, and a sterilizing solution shall be introduced at a manifold connection installed by the Contractor at the point of connection.

C. The solution shall contain 50 parts per million of available chlorine. The chlorinating material shall be either liquid chlorine or calcium hypochlorite. The solution shall be allowed to stand in the system for at least eight hours after which the entire system shall be flushed.

D. After final flushing, all aerators shall be removed, cleaned, and reinstalled. After final flush the residual chlorine shall not exceed 0.2 parts per million.

E. The Architect/Engineer shall be notified 24 hours prior to the procedure so that it can be witnessed.

F. Provide sampling and certified report by an independent testing lab. Provide written Health Department approval of disinfection samples.

3.05 Fuel Gas: Purge all fuel gas systems in accordance with NFPA 54.

END OF SECTION 23 05 91

SECTION 23 05 93 - TESTING AND BALANCING OF MECHANICAL SYSTEMS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section. Division-23 Basic Mechanical Materials Sections apply to work of this section.

1.02 Description of Work:

A. Extent of testing, adjusting, and balancing work (TAB) is indicated by requirements of this section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to, air distribution systems, hydronic distribution systems and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required.

B. Coordination: Coordinate with the General Contractor and Mechanical Contractor responsible for the HVAC system installation as required to complete the TAB work.

1.03 The intent of this specification is to balance HVAC systems within the tolerances listed, maintaining the pressure relationships indicated, with a minimum of noise.

A. Airflow Tolerances:

1. Air Handling: The supply air, return air and outdoor air quantities shall be balanced within ±5% of design values.

2. Exhaust Fans: The exhaust fan quantities shall be set as required to maintain the design exhaust terminal flows within ±5% of design values. If no exhaust terminals exist, exhaust fan air quantities shall be balanced within ± 10% of design values.

3. Ceiling Diffusers, Supply Registers, Return and Exhaust Inlets: Balance to an air quantity within ±10% of the design values.

B. Temperature Tolerances:

1. Air Handling Temperatures: The controlled temperatures at AHUs shall be verified to be under control within ±1°F of design values.

2. Room Temperatures: Balance systems and controls within ±2°F of indicated settings.

C. Pressure Relationships: Where code or design indicates a specific pressure relationship, the pressure relationship shall take precedence over airflow tolerances. Airflow tolerances may need to be held tighter than allowed tolerances to meet pressure relationships.

1.04 Quality Assurance: The TAB Contractor's main office shall be located within 125 miles of the

project site and certified as one of the following:

A. Tester: A firm certified by National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project, who is not the Installer of the systems to be tested and is otherwise independent of the project. Comply with NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems" as applicable to this work.

B. Tester: A firm certified by Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project. AABC-certified firms are independent by definition. Comply with AABC's Manual MN-1 "AABC National Standards", as applicable to this work.

C. Industry Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to measurements, instruments and testing, adjusting and balancing, except as otherwise indicated.

1.05 Job Conditions:

A. Do not proceed with testing, adjusting, and balancing work until HVAC work (including Controls) has been completed and is operable. Ensure that there is no residual work still to be completed.

B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

C. Do not proceed until architectural work that would affect balancing (walls, ceiling, windows, doors) have been installed.

D. Testing may proceed system by system, but each HVAC system must be complete as describe herein.

E. The mechanical contractor shall make any changes in pulleys, belts, and dampers, and/or add dampers as required for correct balancing.

1.06 Approval Submittals

A. Submit the name of the proposed test and balance company for the Engineer's approval within thirty (30) days after awarding of contract.

1.07 Test Reports and Verification Submittals:

A. Submit four (4) copies of the dated test and balance report upon completion of TAB work. The report shall include a list of instruments used for the work. The report shall be signed by the supervisor who performed the TAB work.

PART 2 PRODUCTS

2.01 Patching Materials: Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.

2.02 Test Instruments: Utilize test instruments and equipment of the type, precision, and capacity as recommended in the referenced standard. All instruments shall be in good condition and

shall have been calibrated within the previous six (6) months (or more recently if required by standard).

PART 3 EXECUTION

3.01 General:

A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester.

B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards, and as modified or detailed herein.

C. Test, adjust and balance systems during summer season for air conditioning systems and during winter season for heating systems, including at least a period of operation at outside conditions within 5ºF wet bulb temperature of maximum summer design condition, and within 10ºF dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit. The Contractor shall return for a change of seasons test at no additional cost to the Owner and submit the revised TAB report.

D. Punch List: Prepare a deficiency (punch)list for the Contractor with a copy of the Engineer that lists all items that are incorrectly installed or are functioning improperly. Provide a retest after all items are corrected.

E. Prepare TAB report of test results, including instrumentation calibration reports, in format recommended by applicable standards, modified as required to include all data listed herein.

F. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.

G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.

H. Include in the TAB report recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

I. Include an extended warranty of ninety (90) days after completion of test and balance work, during which time the Engineer, at his discretion, may request a recheck, or resetting of any component as listed in test report. The TAB company shall provide technicians and instruments and make any tests required by the Engineer during this time period.

3.02 Controls

A. Check all HVAC controls for proper location, calibration and sequence of operation.

B. Check operation of all controllers and controlled devices to verify proper action and

direction. Check the operation of all interlocks.

3.03 Air Balancing

A. Leakage tests on ductwork must have been completed before air balancing.

B. Set dampers, volume controls and fan speeds to obtain specified air delivery with minimum noise level. Rebalance as required to accomplish this. Simulate fully loaded filters during test.

C. Set grille deflections as noted on plans. Modify deflections if required to eliminate drafts or objectionable air movement.

D. Record air terminal velocity after completion of balance work.

E. Record final grille and register deflection settings if different from that specified on contract drawings.

F. Record all fan speeds.

3.04 Data Collection:

A. In addition to the data required for any specified performance tests, measure and record the temperatures, pressures, flow rates, and nameplate data for all components listed herein.

B. It is the intent of this section to record data on balanced systems, under normal operating or design conditions.

C. Temperatures:

1. Outside dry and wet bulb temperatures.

2. Dry bulb temperature in each room and at least one wet bulb temperature in each zone.

3. Refrigerant liquid and suction temperatures.

4. Inlet and outlet temperature of each heat exchange device - both fluids.

D. Pressures:

1. Suction and discharge static pressure of each fan.

2. Each refrigerant suction and discharge pressure.

E. Flow rates:

1. Flow rate through each fan.

F. Nameplate Data:

1. Complete nameplate data for all equipment.

2. Motor data to include horsepower, phase, voltage, RPM, full load nameplate current, fuse rating in disconnect switch, number or manufacturer's size designation, and ampere rating of overcurrent and low voltage protection devices in starters.

3.05 All test openings in ductwork shall be resealed in an approved manner.

END OF SECTION 23 05 93

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SECTION 23 07 13 - EXTERIOR INSULATION FOR DUCTWORK

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.03 Approval Submittals:

A. Product Data: Submit producer's data sheets and installation instructions on each insulation system including insulation, coverings, adhesives, sealers, protective finishes, and other material recommended by the manufacturer for applications indicated. Submit for:

1. Flexible duct insulation

1.04 O&M Data Submittals: Submit a copy of all approval submittals. Include in O&M Manual.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers: Subject to compliance with requirements, provide insulation products by Knauf, Owens-Corning, Johns Manville, Certainteed.

2.02 Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, coverings, sealers, mastic, and adhesive) with a flame spread rating of 25 or less, and a smoke-developed rating of 50 or less as tested by ANSI/ASTM 84.

2.03 Flexible Fiberglass Insulation: ASTM C553, Type I, Class B-3 (temperature less than 350ºF). Duct wrap shall be 1 pcf density with UL rated aluminum foil vapor barrier (FSK).

2.04 General Purpose Mastic: Benjamin Foster 35-00 Series, Insulcoustic VIAC Mastic, Childers CP-10, or approved equal. The final selection of this product for the specific application indicated is the responsibility of the insulation supplier. The insulation system must meet the specified application.

2.05 Vapor Barrier Sealant: Benjamin Foster 30-35, Insulcoustic IC-501, 3M EC-1378, Childers CP-30, or approved equal. Provide "Low Odor" type. The final selection of this product for the specific application indicated is the responsibility of the insulation supplier. The insulation system must meet the specified application.

2.06 Adhesive: Benjamin Foster 85-20, Insulcoustic IC-205, 3M EC-35, Childers CP-82, Childers CP-89, or approved equal. The final selection of this product for the specific application indicated is the responsibility of the insulation supplier. The insulation system must meet the specified application.

2.07 Fiber-Glas Mesh: 10x10 Mesh. Foster Mastafab or equal.

PART 3 EXECUTION

3.01 Insulate all supply, return and outdoor air ductwork and the backs of all ceiling supply outlets with 2" thick fiberglass blanket insulation with vapor barrier.

3.02 Installation of Flexible Insulation:

A. Insulate round elbows and fittings with wrap such that thickness is equal to adjoining duct covering. Clean and dry ductwork prior to insulating.

B. Adhere insulation to duct with 50 percent coverage using approved insulation adhesive applied in 6-inch wide swaths with 6-inch spaces between swaths. Additionally secure insulation with perforated pins and Tuff-Bond or by self-sticking pins with a 3/8" self-tapping screw. Space on 12-inch centers and 3 inches from all edges. Ducts up through 24" wide only require one row of pins. Ducts over 24" wide shall have pins spaced as described herein.

C. Lap all joints 2 inches and seal joints with 4-inch wide strips of open mesh glass fabric embedded in two coats of general purpose mastic.

D. Seal all punctures and breaks in aluminum vapor barrier with open mesh glass fabric and vapor barrier sealant.

END OF SECTION 23 07 13

SECTION 23 07 16 - INSULATION FOR HVAC EQUIPMENT AND PIPING

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.03 Approval Submittals:

A. Product Data: Submit producer's data sheets and installation instructions on each insulation system including insulation, coverings, adhesives, sealers, protective finishes, and other material recommended by the manufacturer for applications indicated. Submit for:

1. Flexible unicellular piping insulation

1.04 O&M Data Submittals: Submit a copy of all approval submittals. Include in O&M Manual.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers: Subject to compliance with requirements, provide insulation products by Armstrong, Johns Manville, Knauf, Owens Corning, Pittsburgh Corning, U.S. Rubber, or approved equal. All products shall be asbestos-free.

2.02 Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesive) with a flame-spread rating of 25 or less, and a smoke-developed rating of 50 or less, as tested by ANSI/ASTM E84.

2.03 Pipe Insulation Materials:

A. Flexible Unicellular Pipe Insulation: ASTM C534, Type I. (Tubular, suitable for use to 200ºF.)

B. Staples, Bands, Wires, and Cement: As recommended by the insulation manufacturer for applications indicated.

C. Adhesives, Sealers, Protective Finishes: Products recommended by the insulation manufacturer for the application indicated.

D. Jackets: ASTM C921, Type I (vapor barrier) for piping below ambient temperature, Type II (vapor permeable) for piping above ambient temperature. Type I may be used for all piping at Installer's option.

PART 3 EXECUTION

3.01 General:

A. Install thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Maintain integrity of vapor-barrier on insulation and protect it to prevent puncture and other damage. Label all insulation "ASBESTOS FREE".

D. Do not apply insulation to surfaces while they are hot or wet.

E. Do not install insulation until systems have been checked and found free of leaks. Surfaces shall be clean and dry before attempting to apply insulation. A professional insulator with adequate experience and ability shall install insulation.

F. Do not install insulation on pipe systems until acceptance tests have been completed except for flexible unicellular insulation. Do not install insulation until the building is "dried-in".

3.02 Flexible Unicellular Pipe Insulation:

A. Insulate the following piping systems:

1. Condensate drains from air conditioning units - ½" thick.

2. Refrigerant piping - ¾" thick.

B. Apply insulation in accordance with the manufacturer's recommendations and instructions. Mitre cut insulation to fit pipe fittings. Use approved cement to seal all joints and ends in the insulation.

C. Insulation outside the building shall be protected by a smooth 0.016" thickness aluminum jacket secured with aluminum bands on 12" centers.

END OF SECTION 23 07 16

SECTION 23 09 23 - DIRECT DIGITAL CONTROLS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of Energy Management Control And DDC Systems (EMCS/DDC) work required by this section is indicated on drawings and input/output schedules, and by requirements of this section.

1.4 Refer to other Division-23 sections for installation of instrument wells, valve bodies and dampers in mechanical systems; not work of this section.

1.5 Refer to Division-26 sections for the following work; not work of this section. Power supply wiring for power source to power connection on controls and/or EMCS panels. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

1.6 Provide the following electrical work as work of this section, complying with requirements of Division-26 sections: Control wiring between field-installed controls, equipment, indicating devices, and EMCS/DDC panels.

1.7 Codes and Standards:

1.7.1 Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.

1.7.2 NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.

1.7.3 NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.7.4 Federal Communication Commission (FCC) as required.

1.8 Approval Submittals:

i) Product Data: Submit manufacturer's technical product data for each EMCS/DDC panel and control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials. Include installation instructions and start-up instructions. Provide technical specification data for each component and software module.

1.8.1 Shop Drawings: Submit shop drawings for the EMCS/DDC containing the following information:

1.8.1.1 Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and control

devices.

1.8.1.2 Label each control device with setting or adjustable range of control.

1.8.1.3 Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. The point-to-point wiring diagram shall show all interconnections.

1.8.1.4 Provide details of faces of EMCS/DDC panels, including controls instruments and labeling.

1.8.1.5 Include written description of sequence of operation.

1.9 Test Reports and Verification Submittals:

i) Submit system verification letter from manufacturers representative stating that all HVAC controls have been checked, calibrated, started up and verified for proper operation. State that the Owner training has been completed and provide a roster of attendees.

1.10 O&M Data Submittals:

i) Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device. Include that type data, and a copy of all approval submittals in O&M Manual.

1.10.1 System Manual: In addition to the maintenance data requirements, provide an EMCS/DDC Owner's Manual in a separate binder specifically for this project. This manual shall provide a description of the information flow to and from panels and devices and shall describe the overall communications network. The manual shall also include operating instructions, block diagrams, schematics, schedules, and system descriptions. Instruct Owner's personnel with this manual during the required training periods.

1.10.2 Software: Submit a copy of all software.

1.10.3 Service: Submit name, address, and telephone number of company that will provide service and training for the system.

2 PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with requirements, provide EMCS/DDC control systems of one of the following:

TAC
Trane
Johnson Controls, Inc.
Siemens
Automated Logic

2.2 General: Provide EMCS/DDC control products in sizes and capacities indicated, consisting of valves, dampers, sensors, controllers and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide an EMCS/DDC controls system with the following functional and construction features as indicated.

2.3 FACILITY MANAGEMENT SYSTEM HARDWARE DESCRIPTION

2.3.1 The Facilities Management Control System shall be comprised of dedicated stand-alone local direct digital controllers at each air handling unit, hot water system, chilled water system, fan coil unit, package a/c and vav terminal unit. The local direct digital control modules shall communicate over a network to a global direct digital control module (GCM) as specified to provide centralized access and facility wide control functions.

2.4 Centralized Host Station (CHS)

2.4.1 The CHS shall, in conjunction with the network of local direct digital control modules and global control modules provide the performance requirements within this specification. Each CHS shall be programmed with all hardware and software components to serve as a centralized facility operator station providing color graphics, facility wide access and operator initiation of global control strategies, and centralized documentation for this facility.

2.4.2 IBM-compatible microcomputer with minimum configuration as follows:
Processor: Pentium 4 3.40 GHz or faster.
Memory: 1 GB Dual Channel DDR2 SDRAM at 533 MHz, minimum.
Video Card: 128MB PCI Express x16 (DVI/VGA/TV-out) ATI Radeon X300 SE.
Monitor: 17 inches (16 viewable, minimum), noninterlaced, color, with maximum 0.27-mm dot pitch.
Keyboard: QWERTY, 105 keys in ergonomic shape.
Floppy-Disk Drives: 1.44 MB.
Hard-Disk Drive: 400 GB RAID (2 x 400GB SATA HDDs) minimum.
Embedded Intel PRO/100+ Server Adapter for TCP/IP Communication
DVD-ROM Drive: 24X, IDE CD-ROM with software decoding.
Mouse: Two button.
Tape Backup: 110/220GB,Controller Included, Internal, minimum.
Operating System: Microsoft Windows

2.4.3 UPS (uninterruptible power supply) shall be installed at the server. Size for 50% spare capacity with sufficient capacity to allow emergency power for a minimum of 10 minutes backup.

2.5 Quality Assurance:

2.5.1 Provide equipment of firms regularly engaged in manufacture of EMCS/DDC equipment, of types required, whose products have been in satisfactory use in similar service for not less than three years. Provide evidence that software has been in use satisfactorily for at least one year.

2.5.2 Contractor shall have at least three years experience in the installation and servicing of EMCS/DDC equipment similar to that being installed. Contractor shall have an office within 100 miles of the project and shall maintain a remote terminal capable of communication with the EMCS/DDC during the year warranty period. The contractor shall be capable of performing emergency service at the project site within 4 hours of the call for service.

2.6 Control Valves: Provide factory-fabricated electric control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provided selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motors with proper shutoff ratings for each individual application.

2.6.1 Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1, and maximum full flow pressure drop of 10 feet head unless otherwise indicated. Two-way valves shall be suitable for dead-end service.

2.6.2 Single-Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.

2.6.3 Double-Seated Vales: Balanced plug-type, with cage type trim providing seating and guiding surfaces for plugs on "top and bottom" guided plugs.

2.6.4 Valve Trim and Stems: Polished stainless steel.

2.6.5 Packing: Spring-loaded Teflon, self-adjusting.

2.6.6 Terminal Unit Control Devices: Provide compact electric control valves for control of terminal units including, but not necessarily limited to convectors, unit heaters, finned tube radiation, reheat coils, and fan coil units that are of integral motor type. Provide modulating type valves. Valve actuators shall be 24 volts .

2.7 Dampers: Refer to Division-23 Section "Ductwork Accessories" for dampers. Actuators are work of this section.

2.8 Actuator Motors: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or two position action as specified.

2.8.1 Provide permanent split-capacitor or shaded pole type motors with gear trains completely oil-immersed and sealed. Equip spring-return motors, where indicated on drawings or in operational sequence, with integral spiral-spring mechanism. Furnish entire mechanism in housing designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

2.8.2 Equip motors for outdoor locations and for outside air intakes with "O-ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at 10°F.

2.8.3 Furnish non-spring return motors for dampers larger than 25 sq. ft. and for valves larger than 2½". Size for running torque rating of 150 inch-pounds and breakaway torque rating of 300 inch-pounds. Size spring-return motors for running torque rating of 150 inch-pounds and breakaway torque rating of 150 inch-pounds.

2.9 EMCS/DDC Associated Components:

2.9.1 Provide field-programmable microprocessor-based, stand-alone EMCS/DDC panels as specified herein. The EMCS/DDC panel manufacturer shall be responsible for the complete engineering of the panel. The panel shall be UL listed and housed in a key locked metal cabinet. Parts shall be plug in (modular) for easy repair or expansion. Power input shall be 24V or 120 V. Relays and contacts shall be rated at 24 VA at 24 VAC or 125 VA at 120 and 230 VAC, as required.

2.9.2 The panels shall have the capability to be upgraded through modules.

2.9.3 Programming shall utilize low level English language.

2.9.4 Coordinate with the EMCS/DDC manufacturer and ensure that all wire and conduit (type and

size) is suitable for the equipment being installed.

2.9.5 Each EMCS/DDC panel shall have at least the minimum number of output and input channels for controlling loads as shown on the drawings.

2.9.6 Each EMCS/DDC panel shall have a data outlet for local access by laptop computer.

2.9.7 Panels shall have a keyboard with an access code to prevent unauthorized entry. The keyboard shall be used to display setpoints and valves, and for override and programming.

2.9.8 Visual display shall provide prompted programming and shall indicate all system parameters including current time, day and month and error messages.

2.9.9 Provide for 48 hours minimum of battery backup for field programs in RAM. All logic, utility, calculations, and control functions shall be in ROM.

2.9.10 The control console shall have the capability to communicate with other system components by using a two-wire communication line.

2.9.11 The system shall be driven by a line power synchronized program clock. Clock display shall include year, month, day of month and time in hours, minutes and seconds. The clock shall also automatically update for days in month, daylight savings time, and leap year.

2.9.12 Programming shall be self-prompting such that the operator is guided to the next entry item. Field programming shall be readily accomplished by the user.

2.9.13 Diagnostics and Serviceability: Provide built-in, self-testing for lights, digital display, and memory. Provide all electronics in modular form of the plug-in type.

2.10 EMCS/DDC Functions:

2.10.1 Control Functions: Provide for closed-loop control by proportional, proportional-integral (PI), proportional-integral derivative (PID), incremental, and/or floating modes. Control accuracy: plus or minus 0.5° F of set point for all steady state load conditions. Provide specific control functions described on the drawings.

2.10.2 Management Functions: Provide capability for trending of variables, totalizing, and historical data storage. Provide for monitoring of selected parameters locally and remotely. Provide a graphical representation of the trended values at the CHS. The user shall have the capability of creating custom trends and reports.

2.10.3 Time of Day Program: Provide the ability to turn loads on and off per the input/output schedule and have a time initiate resolution of one minute. The system shall be designed such that equipment can have a different schedule each day of the week and multiple on-off schedules per day. The system shall include a holiday feature which shall include its own time schedules and holiday duration. It shall be possible to program holidays up to one year in advance. The program shall automatically changeover from Daylight Savings to Standard Time.

2.10.4 Demand Control: Provide kW demand limiting with adjustable load shedding (setpoint and schedule).

2.10.5 Timed Override: Remote override timers (where indicated on the drawings and input/output schedule) shall enable after hour or off-schedule use of the controlled equipment.

2.10.6 Automatic Restart Programming: Provide for sequential automatic restart of all equipment in the normal mode following a power outage.

2.10.7 Temperature Indication: The EMCS shall monitor remote temperatures where indicated on the drawings and input/output schedule.

2.10.8 Alarms: Provide alarms for control points out of range (adjustable) and provide alarm summary capability.

2.10.9 Graphics: At a minimum, the following graphics shall be provided. Provide a floor plan of each floor of each building with temperatures shown in the area of the floor plan where the sensors are located. Provide a link from the temperature display to the associated equipment screen. Equipment screens shall have an equipment graphic with all points of data shown in locations on the equipment graphic that match the physical locations of those points on the actual equipment being represented. Equipment screens shall be provided for all controlled equipment. Air handling units shall be shown on the floor plans with a link to their equipment screens. All equipment in the central plant shall be shown on the central plant floor plan with a link to their equipment screens.

2.11 Web Based Operator Interface:

2.11.1 The EMCS shall provide a web based graphical interface that allows users to access the EMCS data via the Internet, extranet or Intranet. The interface shall use HTML based ASP pages to send and receive data from the EMCS to a web browser.

2.11.2 A web server computer shall be provided. The web server shall use Microsoft's IIS Server 6.0 with Windows Server 2003, or IIS 5.0 with Windows 2000, and support browser access via Microsoft Internet Explorer 5.0 (or higher), or Navigator Netscape 6.0 (or higher).

2.11.3 All information exchanged over the Internet shall be optionally encrypted and secure.

2.11.4 Access to the web interface shall be password protected. A user's rights and privileges to points and graphics will be the same as those assigned at the EMCS workstation. An option shall be provided to only allow users "read" access via the web browser, while maintaining "command" privileges via the central workstation.

2.11.5 Commissioning of the web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the EMCS central workstation shall be available to users via a web browser.

2.11.6 The web-based interface shall provide the following functionality to the users, based on their access and privilege rights:

a. Logon Screen
b. Alarm Display
c. Graphic Display
d. Point Details
e. Point Commanding
f. Scheduling
g. Run Reports

2.11.7 The web server licensing options shall allow concurrent access by (15) browser connections.

2.11.8 Coordinate with the Owner for Internet connections, ISP services, firewalls or proxy servers

required to support web access.

2.12 Web Browser Clients

2.12.1 The system shall be capable of supporting 64 clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, are not acceptable. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.

2.12.2 The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

2.12.3 The Web browser client shall support at a minimum, the following functions:

2.12.3.1 User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

2.12.3.2 Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

2.12.3.3 HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

2.12.3.4 Storage of the graphical screens shall be in the Building Control Units (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

2.12.3.5 Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.

2.12.3.6 User’s shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
b. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
c. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
d. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
e. View logs and charts
f. View and acknowledge alarms

2.12.3.7 The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home

page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

2.12.3.8 Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.13 EMCS/DDC Associated Components:

2.13.1 Communication Modules: The EMCS/DDC shall be supplied with all necessary communication modules and hardware as required for remote programming and recalling of data. Provide all required cable and conduit to link to the host computer. Provide all necessary equipment to allow remote programming and monitoring of input channels and on/off status from the remote system. Provide download capability from the host computer. The EMCS/DDC shall be capable of being remotely programmed and monitored via a phone line and modem, over the building Ethernet system and over the Internet from any location. Access shall be secure.

2.13.2 Remote Data Terminal: Where indicated, provide a complete microcomputer IBM PC or equal with disk drive, terminal, modem, monitor and printer. Provide software to program and recall data from all remote locations. The system shall be installed such that the operator can dial each EMCS panel via voice grade telephone circuits. It shall be possible to perform the following from the remote terminals.

2.13.2.1 Program the entire EMCS/DDC system.

2.13.2.2 Read system temperatures, determine system set points, determine load on-off status, and determine program function causing load status.

2.13.2.3 Perform energy audits, data gathering, and logging.

2.13.2.4 Troubleshoot the EMCS/DDC via diagnostic programs. The diagnostic messages displayed on the EMCS/DDC readout shall also be printed at the terminal when the system is interrogated.

2.13.3 Hardware: Provide key-locked NEMA-1 metal cabinet, modular components for expandability and maintenance, keyboard entry, battery backup to prevent loss of memory for at least 48 hours, local manual override, AC line voltage surge protection.

2.13.4 Channel Bypass and Override: Provide bypass switches for each output channel such that the controlled device can operate normally as if the EMCS/DDC was not installed. Provide remote override timers where shown in the input/output schedule on the drawings.

2.13.5 Associated Hardware: Provide actuators, relays, and other interface devices as required to execute the indicated control functions. Coordinate with Division-23 section "HVAC Control Sequences" and the input/output schedule on the drawings.

2.14 EMCS/DDC Input Devices:

2.14.1 Temperature Sensors: Provide nickel resistance temperature detector (RTD) type sensors for duct, well or room mounting as required by duty indicated. Accuracy: plus or minus 0.5°F.

2.14.2 Hydronic Differential Pressure Transmitter: Provide self-contained, variable capacitance type differential pressure transmitters with the following features. Subject to compliance with requirements, provide transmitters of one of the following: Rosemont, Foxboro, Leslie,

Yokagawa.

2.14.2.1 Sealed electronics compartment, suitable for duty at 90°F, 100% RH. Provide NEMA 4 enclosure.

2.14.2.2 Output 4-20 ma DC, isolated linear signal.

2.14.2.3 Design pressure: 2000 psi, design overrange differential: 2000 psi with minimal adverse affect on output.

2.14.2.4 Accuracy: plus or minus 0.25% of span.

2.14.2.5 Stability: plus or minus 0.25% of range limit.

2.14.2.6 Provide zero and span adjustments. Set span for each transmitter based on duty, not at maximum unless required.

2.14.1 Differential and Static Pressure Sensors (Air): Provide 0-6" w.g. adjustable in 2" w.g. span pressure sensors with ±0.5% full scale accuracy. Provide zero and span adjustments. Provide over-pressure protection to 10 psig positive or negative.

2.14.2 Differential Pressure Switches (Air): Provide 0.05 to 5" w.g. differential pressure switches with adjustable setpoint and SPDT contact rated for duty indicated. Provide over-pressure protection to 1 psig positive or negative.

2.14.3 Humidity Sensors: Bulk polymer sensor element. Accuracy 2% at 10-90% RH with linear output.

2.14.4 Airflow Measuring Stations: Provide airflow/temperature measurement devices where indicated on the plans. Each measurement device shall consist of one or more sensor probe assemblies and a single microprocessor-based transmitter. Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature. Airflow Measuring Stations shall be EBTRON Silver Series or approved equal.

2.15 Guarantee:

2.15.1 All components, parts, and assemblies shall be guaranteed against defects in material and workmanship for a period of one year after acceptance. Expressed warranties are conditionally based on the requirement that the items covered within the guarantee are used and maintained in accordance with the manufacturer's recommendations. Guarantee commences at time of acceptance and continues for one year. Acceptance shall not occur until the Owner's operators are able to use the EMCS/DDC and receive reliable information from inputs and outputs.

2.15.2 The first year guarantee shall, as part of the base bid for the EMCS/DDC, include full service and maintenance of the EMCS/DDC. This service and maintenance shall include all necessary repair, reprogramming, calibration, cleaning, minimum (4) quarterly inspections, call back service, etc. This first year service, maintenance and guarantee shall be included in the base bid of the EMCS/DDC.

3 EXECUTION

3.1 Examine areas and conditions under which EMCS/DDC work is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 Installation of EMCS/DDC:

3.2.1 General: Install systems and materials in accordance with manufacturer's instructions, shop drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications. Mount panels at convenient locations and heights.

3.2.2 Control Wiring: The term "control wiring" is defined to include wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices. Install all control wiring in conduit.

3.2.3 Wiring System: Install complete control wiring system for the EMCS/DDC. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

3.2.4 Install control wiring in accordance with the National Electric Code and Division 26 requirements.

3.2.5 Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system. Tag all sensor wiring to identify zone number and room number where sensor is located.

3.2.6 Label all sensors, valves, dampers, safety devices and controllers with engraved tags matching the shop drawings.

3.3 Programming of EMCS/DDC:

3.3.1 The Contractor shall obtain operational schedules for the controlled equipment from the Engineer. Submittal data relevant to operational schedules shall be forwarded from the Contractor to the Engineer. Upon receipt of approval, the Contractor shall proceed with installation, setup, calibration and check out of the various control and monitoring systems.

Having completed component and system installation, the Contractor shall submit a written request to the Engineer to inspect and approve their satisfactory operation.

3.3.2 The EMCS/DDC shall perform all functions on the equipment as describes in Division-23 section “HVAC Sequence of Operation and as called for in the input/output schedule on the drawings. This schedule, in conjunction with the drawings, defines the scope and extent of the project with regard to the required number of panels, control point relays, and devices. Field verify voltages at point-of-interface and provide relays as required.

3.3.3 Channel numbers may be reassigned by the Contractor during shop drawing submittal.

3.3.4 Model numbers, horsepowers, voltages, and other information equipment where listed on the drawings are for Contractor's convenience. Verify all information in the field as necessary for preparation of shop drawings.

3.4 Functional Requirements of EMCS/DDC:

3.4.1 Provide all necessary relays, sensors, wiring and contacts to achieve proper operation.

3.4.2 Connect EMCS/DDC panels to remote panels where shown.

3.5 Adjusting and Cleaning:

3.5.1 Startup: Startup, test, and adjust the EMCS/DDC in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.5.2 Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5.3 Final Adjustment: After completion of installation, adjust the program, relays, interface devices, and similar equipment provided as work of this section for optimum operation.

3.6 VFD System Adjustment: The drive/controller supplier shall set all adjustments and setpoints for initial operation. The hydronic system and all pumps and control valves shall be monitored for proper operation. The ductwork and all fans and terminal units shall be monitored for proper operation . It shall be recognized that final settings will be obtained by trial-and-error by necessity. Call backs to achieve proper settings shall be included in the base bid.

3.7 Owner's Instructions:

3.7.1 During system startup and at such time acceptable performance of the EMCS/DDC hardware and software has been established, the Contractor shall provide on-site operator instruction. This instruction shall be performed during normal working hours and shall be conducted by a competent representative of the Contractor familiar with the system's software, hardware and accessories. The Contractor shall maintain a roster of all attendees at all training sessions.

3.7.2 At a time mutually agreed upon during system training as stated above, the Contractor shall give up to 40 hours (as needed) of instruction to the Owner's designated personnel on the operation of all equipment within the EMCS/DDC and describe its intended use with respect to the programmed functions specified.

3.7.3 Operator orientation of the EMCS/DDC shall include, but not be limited to, the overall operational program, equipment functions both individually and as part of the total integrated system, commands, advisories, and appropriate operator intervention required in responding to the EMCS/DDC operation.

3.7.4 Provide at least 14-day notice to Owner and Engineer of training dates.

3.8 System Verification: The manufacturer's authorized representative shall state in writing to the Engineer that the EMCS/DDC system is operating properly, final adjustments and calibrations are complete, and Owner training has been accomplished.

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SECTION 23 31 13 - HVAC METAL DUCTWORK

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.03 Extent of HVAC metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

1.04 Refer to other Division-23 sections for exterior insulation of metal ductwork.

1.05 Refer to other Division-23 sections for ductwork accessories.

1.06 Codes and Standards:

A. SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" 1985 Edition for fabrication and installation of metal ductwork, unless otherwise noted.

B. NFPA 90A Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

C. NFPA 96 Compliance: Comply with NFPA 96 "Standard for Installation of Equipment for Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment".

1.07 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data and installation instructions for the following.

1. Factory-fabricated ductwork
2. Sealants
3. Flexible duct
4. Spin-in fittings
5. Side take-off fittings

B. Shop Drawings: Submit scaled layout drawings of HVAC metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

PART 2 PRODUCTS

2.01 Ductwork Materials:

A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.

B. Galvanized Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality; with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations. Stamp gauge and manufacturer's identification on each sheet. Break sheets so that identification is exposed.

C. Stainless Steel Sheet: Where indicated, provide 18-gauge stainless steel complying with ASTM A 167; Type 304 with No. 4 finish where exposed to view in occupied spaces. Provide No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.

2.02 Miscellaneous Ductwork Materials:

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Duct Sealant: Provide non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.

C. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork. For exposed stainless steel ductwork, provide matching stainless steel support materials.

D. Flexible Ducts: Provide flexible ductwork with an R-value of R-6unless the ductwork is in a ceiling return plenum. The use of flexible ductwork for connection of supply air and return air devices is acceptable only where shown on the drawings.

1. Construction: Provide reinforced metalized polyester jacket that is tear and puncture resistant, air tight inner core with no fiberglass erosion in the air stream and an encapsulated wire helix. Flexible ductwork shall have a recommended operating pressure of 6" w.g. for sizes 4" through 12" diameter and 4" w.g. for sizes 14" through 20" diameter. All diameters shall be suitable for a negative operating pressure of 0.75" w.g. Flexible ductwork shall meet the requirements of UL-181, the Florida Energy Code, SBCC, NFPA 90A and NFPA 90B.

2. Acceptable Manufacturers: Subject to compliance with requirements, provide R-6 flexible ductwork by: Atco 36, Flexmaster 8M-R6 or Thermaflex M-KE R6.

E. Spin-in and Side Take-off Fittings: Provide round branch run-outs as follows.

1. Where duct height does not permit the use of conical spin-in fittings, use low profile side take-off fittings equal to Crown 3300-DS or Flexmaster STOD-BO.

F. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15°

change of direction per section. Unless specifically detailed otherwise, use 45° laterals and 45° elbows for branch takeoff connections. Where 90° branches are indicated, provide conical type tees.

2.03 Fabrication:

A. Shop fabricate ductwork in 4, 8, 10 or 12-ft lengths, unless otherwise indicated or required to complete runs. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.

B. Shop fabricate ductwork of gauges and reinforcement complying with SMACNA "HVAC Duct Construction Standards", except provide sealant at all joints. Supply duct from air conditioning units and all return and exhaust duct shall be minimum 2" pressure class unless otherwise noted.

C. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1½ times associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30° for contracting tapers and 20° for expanding tapers.

D. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Ductwork Accessories" for accessory requirements.

2.04 Factory-Fabricated Low Pressure Ductwork (Maximum 2" W.G.):

A. Material: Galvanized sheet steel complying with ASTM A 527, lockforming quality, with ASTM A 525, G90 zinc coating, mill phosphatized.

B. Gauge: 28-gauge minimum for round ducts and fittings, 4" through 8" diameter. 26-gauge minimum 9" through 14", 24-gauge minimum 15" through 26".

C. Elbows: One piece construction for 90° and 45° elbows 14" and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint.

D. Divided Flow Fittings: 90° tees, constructed with saddle tap spot welded and bonded to duct fitting body.

E. Acceptable Manufacturers: Subject to compliance with requirements, provide factory-fabricated ductwork by Semco Mfg., Inc. or United Sheet Metal Div., United McGill Corp, or approved equal.

2.05 Kitchen Exhaust Ducts: Fabricate kitchen exhaust ducts and supports used for smoke and vapor removal from cooking equipment of 16-gauge minimum galvanized steel where concealed, and of 18-gauge minimum stainless steel where exposed. For duct construction, comply with SMACNA "HVAC Duct Construction Standards", and NFPA 96 "Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment". Continuously weld all seams and joints to be grease tight. Provide high temperature fiber blanket thermal insulation incapsulated in a fiberglass-reinforced aluminized polyester foil, 6 pcf, 1.5” thick. The fiber blanket shall have a continuous use limit of 1000C and a Smoke Developed Index and Flame Spread Index of 0/0. 3M “Fire Barrier Duct Wrap 615” or equal.

PART 3 EXECUTION

3.01 General: Examine areas and conditions under which HVAC metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 Installation Of Metal Ductwork:

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.

B. Supports: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in work. Install self-drilling screw anchors in prestressed concrete or existing work.

C. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements. Seal joints in round or oval ductwork with hard cast or shrink bands, and sheet metal screws, or by welding. High velocity rectangular ducts shall have approved joints and be made airtight with sealer or welding.

D. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally. Avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to ½" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. In finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction or above suspended ceilings, unless specifically noted as "Exposed". Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

E. Electrical Equipment Spaces: Do not route ductwork through transformer vaults or other electrical equipment spaces and enclosures.

F. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1½". Fasten to duct and substrate. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate.

G. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

H. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct

Construction Standards. Fan discharge outlet ducts shall be installed correctly with regard to "system effect" per AMCA Publication 201.

3.03 Installation of Flexible Ducts:

A. Maximum Length: For any duct run using flexible ductwork, do not exceed 5'-0" extended length. Flexible duct shall only be allowed as detailed on the drawings.

B. Installation: Install in accordance with Section III of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible". Support flexible ducts to eliminate pinching and kinking which would restrict flow.

C. Low Pressure: Peel back insulation and slide the inner core over the spin-in or diffuser neck, seal with duct sealant and install Panduit strap tightly. Slide insulation back over the inner core and install another Panduit strap over the insulation outer jacket. Tape is not acceptable.

D. Seal all exposed edges of fiberglass insulation with glassfab and mastic.

3.04 Installation of Kitchen Exhaust Ducts: Fabricate joints and seams with continuous welds for watertight construction. Provide for thermal expansion of ductwork through 2000° F temperature range. Install without dips or traps which may collect residues, except where traps have continuous or automatic residue removal. Provide access openings at each change in direction, located on the sides of the duct 1½" minimum from bottom. Provide access openings with grease-tight covers of same material as duct. Slope horizontal ducts at 1" per foot.

3.05 Leakage Tests: After each duct system is completed, test for duct leakage in accordance with Sections 3 and 5 of the SMACNA HVAC Air Duct Leakage Test Manual. Test pressure shall be equal to pressure class of duct, less 0.5" static pressure. Repair leaks and repeat tests until total leakage is less than 5% of system design air flow for low pressure systems and less than 1% for systems rated over 3".

3.06 Equipment Connections: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.07 Clean ductwork internally free of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. Keep ducts closed with poly during construction to prevent contamination by construction dust and debris.

3.08 Balancing: Refer to Division-23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

3.09 System Adjustment: Adjust the system to provide functional operation to the extent possible, and leave ready for Testing and Balancing work. It is not the intent of this section to provide final testing and balancing, but to leave the system operational with a minimum of noise.

END OF SECTION 23 31 13

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SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.03 Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.

1.04 Refer to other Division-23 sections for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.05 Codes and Standards:

A. SMACNA Compliance: Comply with applicable portions of both SMACNA "HVAC Duct Construction Standards, Metal and Flexible" .

B. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems" pertaining to installation of ductwork accessories.

1.06 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions as follows:

1. Low pressure manual dampers
2. Control dampers
3. Counterbalanced relief dampers
4. Duct access doors
5. Flexible connections

B. O&M Data Submittals: Submit manufacturer's maintenance data including parts lists. Include this data, product data, and a copy of approval submittals in O&M manual.

PART 2 PRODUCTS

2.01 Dampers:

A. Low Pressure Manual Dampers: Provide 16 gauge dampers of single-blade type (12" maximum blade width) or multiblade type. Damper blades to be gang-operated from a single shaft with nylon or ball bearings on each end. Provide indexed locking quadrant. Parallel or opposed blade style is acceptable. Provide 2" standoff on locking quadrant for externally insulated duct.

B. Control Dampers: Extruded aluminum (6063-T5) damper frame shall not be less than 0.080” in thickness. Damper frame shall be 4” deep x 1", with duct mounting flanges on both sides of frame. Damper frame shall have a 2" mounting flange on the rear of the damper when installed as Extended Rear Flange install type. Aluminum frame shall be clear anodized to a minimum thickness of 0.7 mil deep. Frame shall be assembled using stainless steel screws. Welded frames shall not be acceptable. Actuators (motors) are provided by control contractor.

1. Blades shall be maximum 6.4” deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 0.06”, clear anodized to a minimum thickness of 0.7 mil deep.

2. Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

3. Hexagonal control shaft shall be $^{7}/_{16}$". It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be stainless steel.

4. Linkage hardware shall be aluminum and stainless steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with stainless steel cup-point trunnion screws to prevent linkage slippage. Linkage that consists of metal rubbing metal will not be approved.

5. Dampers shall be designed for operation in temperatures ranging from -40°F to 212°F.

6. Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

7. Dampers shall be custom made to required size, with blade stops not exceeding 1¼” in height.

8. Dampers shall be opposed blade for modulating dampers or parallel blade action for open/shut dampers.

9. Dampers shall be installed in the following manner: Installed in Duct

10. Installation of dampers must be in accordance with manufacturer’s current installation guidelines, provided with each damper shipment.

11. Field supplied intermediate structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.

12. Acceptable Manufacturers: Subject to compliance with requirements, provide access doors by TAMCO (T.A. Morrison & Co, Inc), Pottorff, Ruskin, or approved equal.

2.02 Turning Vanes: Provide manufactured or fabricated single wall turning vanes and vane runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards".

2.03 Duct Access Doors:

A. General: Provide duct access doors of size indicated, or as required for duty indicated.

B. Construction: Construct of same or greater gauge as ductwork served. Provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.

C. Acceptable Manufacturers: Subject to compliance with requirements, provide access doors by Air Balance, Inc., Duro Dyne Corp., Ruskin Mfg. Co., Nailor Industries, or Ventfabrics, Inc.

2.04 Flexible Connections:

A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following: Duro Dyne Corp., Flexaust (The) Co., or Ventfabrics, Inc.

PART 3 EXECUTION

3.01 Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 Installation of Ductwork Accessories:

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install balancing dampers at all main ducts adjacent to units in return air, outside air and where indicated.

C. Install control dampers in the outside air duct for each outside air unit and otherwise as shown.

D. Install turning vanes in square or rectangular 90º elbows in supply, return, and exhaust air systems, and elsewhere as indicated.

E. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

F. Install flexible connections in ductwork such that the clear length of the connector is approximately two inches. Provide thrust restraints as required. Flexible material shall not be so slack as to take a definite concave or convex shape during fan operation.

G. Coordinate with other work, including ductwork, as necessary to interface installation of

ductwork accessories properly with other work.

3.03 Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories as required to obtain proper operation and leakproof performance.

3.04 Adjusting And Cleaning:

A. Adjusting: Adjust ductwork accessories for proper settings.

B. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing". However, the system shall be left functional with all dampers open or throttled.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 33 00

SECTION 23 34 00 - FANS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.03 Extent of fan work required by this section as indicated on drawings and schedules, and by requirements of this section.

1.04 Coordination:

A. Refer to Division-7 sections for installation of prefabricated roof curbs; not work of this section. Furnishing prefabricated roof curbs is part of this section's work.

B. Refer to Division-23 section "Testing, Adjusting, and Balancing" for balancing of fans.

C. Refer to Division-23 HVAC control systems sections for control work required in conjunction with fans.

D. Refer to Division-26 sections for power supply wiring from power source to power connection on fans. Division-26 work will include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

1.05 Codes and Standards:

A. AMCA Compliance: Provide fans which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Ratings Seal.

B. UL Compliance: Provide fans which are listed by UL and have UL label affixed.

1.06 Approval Submittals:

A Product Data: Submit manufacturer's technical data for fans, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions. Submit assembly-type drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details. Include statement that resin selection is suitable for chemical resistance to the specific application at 170ºF.

1. Fans
2. Vibration Control

1.02 O&M Data Submittals: Submit maintenance data and parts list for each type of fan, accessory, and control. Include these data, a copy of approved submittals, and wiring diagrams in O&M Manual.

PART 2 PRODUCTS

2.01 General: Except as otherwise indicated, provide standard prefabricated fans of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation. Provide accessories as listed in the schedule on the drawings and as described herein. Motors shall be high efficiency per Division-23 section "Motors".

2.02 Acceptable Manufacturers: Subject to compliance with requirements provide fans manufactured by Acme, Greenheck, Loren Cook, Penn, Twin City Fan and Ventilator, Captive Aire, or approved equal unless otherwise noted herein.

2.03 Centrifugal Ceiling Exhausters:

A Fan Assembly: Provide steel housing, plastic or aluminum grille, backdraft damper, statically and dynamically balanced fan wheel, permanently lubricated motor with internal thermal overloads, vibration isolation and all required mounting hardware and brackets. Provide acoustically treated housing for all fans larger than 60 cfm. Mounting type shall be as indicated on the drawings or on the schedule.

B Connectors: Provide adaptors, connectors, and eave elbows as required to connect fan discharges to outlets.

C Outlets: Provide where shown on the drawings (or required by the installation) wall caps, vent caps, or roof jacks, each with birdscreen, to match fans and surrounding construction.

2.04 In-Line Centrifugal Fans:

A Housing: Provide round aluminum or square weather tight housing constructed of steel and painted inside and out with an epoxy finish. Provide venturi type inlet.

B Fan Wheels: Provide aluminum air foil type, backward curved, statically and dynamically balanced.

C Drive: Provide direct or belt drive as scheduled with pre-lubricated, ball bearing, continuous duty type motors. Provide vibration isolation equipment for the entire drive.

D Isolation and Support: Provide spring type vibration isolators and fan support brackets.

2.05 Cooking Hood Fan Package: Except as otherwise indicated, provide packaged, factory-built, roof-mounted, fan package assemblies of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation. The entire unit shall be accessible from the roof through hinged access doors for steam cleaning all ducts and fans from the roof. The unit shall include the following components.

A. Exhaust Fan: Provide heavy gauge aluminum upblast centrifugal exhaust fan with integral grease drain trough and drain fitting. Provide aluminum fan wheel, statically and dynamically balanced. Motor and drive shall be isolated from the air stream and shall be cooled by clean, outside air only. Provide high efficiency motors per Division-23 section "Motors". Provide fully adjustable belt drive and prelubricated ball bearing motor mounted on vibration isolation equipment. Provide birdscreen and thermal barrier. Provide hinged access. The fan shall be AMCA approved and UL-listed for grease removal.

B. Supply Fan: Provide in-line, centrifugal, horizontal supply fan with painted, weatherproof finish. Provide aluminum fan wheel statically and dynamically balanced. Motor and drive shall be mounted on vibration isolation equipment. Provide high efficiency motors per Division-23 section "Motors". Provide fully adjustable belt drive and prelubricated ball bearing motor. Provide 18-gauge painted galvanized steel housing and angle iron support legs. Provide service access to all components.

C. Intake: Provide supply fan intake with birdscreen and 1-inch washable aluminum filters. Maximum face velocity shall be 500 fpm. Provide motorized backdraft damper that opens and closes with supply fan operation. Intake shall be at least 10' from exhaust fan.

D. Curb: Furnish 12" high, roofed-over type, prefabricated, aluminum curb with integral pressure treated wood nailer and 1-inch thick rigid insulation. Provide curb extensions and sections as required to meet NFPA requirements for exhaust discharge height and supply-exhaust fan separation.

E. Controls: Provide prewired control center complete with: remote control station at hood, master fused disconnect switch, magnetic motor starters with thermal overloads and manual reset, fused 24 volt control transformer, relays, and wiring. The system shall be UL-listed and require single point connection for fan power. The system shall provide fully automatic operation.

2.06 Propeller Wall Fans:

F. Housing: Provide heavy duty all-welded steel housing and supports with epoxy finish. Panels shall have streamlined orifices.

G. Fan: Provide air foil type steel or aluminum propellers.

H. Drive: Provide direct or belt drive as scheduled with pre-lubricated, ball bearing, continuous duty type motors. Provide vibration isolation equipment for the entire drive.

I. Wall Collar or Housing: Provide galvanized steel fan wall collar or housing as required.

J. Fan Guard: Provide OSHA approved galvanized steel mesh fan guard.

2.07 Vibration Isolation: Mount fans on vibration isolators in accordance with the requirements of Division-23 section "Vibration Isolation" and the following list.

A Equipment Mountings: Type EM4.

B Hangers: Type HA3.

PART 3 EXECUTION

3.01 General: Except as otherwise indicated or specified, install fans in accordance with manufacturer's installation instructions and recognized industry practices to insure that fans serve their intended function.

3.02 Coordinate fan work with work of roofing, walls, and ceilings as necessary for proper interfacing. Framing of openings, caulking, and curb installation is not work of this section.

3.03 Ductwork: Refer to Division-23 section "Ductwork". Connect ducts to fans in accordance

with manufacturer's installation instructions. Provide flexible connections in ductwork at fans.

3.04 Install fans on vibration isolation equipment as required. Set level and plumb.

3.05 Roof Curbs: Furnish roof curbs to roofing Installer for Installation.

3.06 Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Verify proper rotation direction of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.07 Remove shipping bolts and temporary supports within fans. Adjust dampers for free operation.

3.08 Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.09 Cleaning: Clean factory-finished surfaces. Remove all tar and soil. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 34 00

SECTION 23 37 13 - GRILLES, REGISTERS AND CEILING DIFFUSERS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.03 Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

1.04 Refer to other Division-23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets and for balancing of air outlets and inlets; not work of this section.

1.05 Codes and Standards:

A. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual". Provide air outlets and inlets bearing ADC Certified Rating Seal.

B. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.06 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets indicating construction, finish, and mounting details.

B. Performance Data: For each type of air outlet and inlet furnished, provide aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections and data as required.

1.07 O&M Data Submittals: Submit cleaning instructions for finishes and spare parts lists. Include this data and a copy of approval submittals in O&M manual.

PART 2 PRODUCTS

2.01 General:

A. Except as otherwise indicated, provide manufacturer's standard grilles, registers, and ceiling diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Manufacturers not listed in the following specification will not be considered for approval unless accepted by addendum prior to bid.

C. Performance: Provide grilles, registers and ceiling diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each

size device equal to the basis of design.

D. Ceiling and Wall Compatibility: Provide grilles, registers and diffusers with border styles that are compatible with adjacent wall and ceiling systems, and that are specifically manufactured to fit into ceiling module or wall with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems and walls which will contain each type of ceiling diffuser, grille, or register.

E. Appearance: All grilles and registers shall be aluminum construction and all diffusers shall be aluminum construction, unless otherwise noted, with uniform matching appearance for each type of outlet. Ceiling mounted grilles and registers shall be set to be sight tight from the predominant exposure.

F. Finish: All ceiling mounted grilles, registers, and diffusers shall be finished with baked white enamel. Wall and door mounted grilles and registers shall be finished with clear anodized finish .

2.02 Acceptable Manufacturers: Subject to compliance with requirements, provide products by Titus, Nailor Industries, or Metal Aire.

2.03 Rectangular Ceiling Diffusers (CD): Provide rectangular face with removable inner core, no corner joints. If square or rectangular neck is provided, provide square to round adaptor as required. Provide lay-in panel as required. Provide trim ring for diffusers in hard ceilings to allow opening to be used for access.

2.04 Return, Transfer, and Exhaust Grilles: Provide grilles with one set of 45 degree fixed louvers, parallel to the long dimension. Provide mounting frame for all wall and plaster ceiling installations.

PART 3 EXECUTION

3.01 Coordinate installation with ceiling and light fixture installation. Locate ceiling outlets as indicated on architectural Reflected Ceiling Plans. Unless otherwise indicated, locate ceiling outlets in the center of acoustical ceiling modules with sides parallel to the grid.

3.02 Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

3.03 Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

3.04 Set air volumes to values shown on the drawings so that the system is functional. Leave ready for test and balance contractor.

3.05 Furnish to Owner three operating keys for each type of outlet and inlet that require them; obtain receipt.

END OF SECTION 23 37 13

SECTION 23 37 26 - WALL LOUVERS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.03 Extent of wall louver work is indicated by drawings and schedules, and by the requirements of this section.

1.04 Refer to other Division-23 sections for ductwork, duct accessories and controls work.

1.05 AMCA Compliance: Test and rate louvers in accordance with AMCA Standard 500. Provide AMCA certified rating seal. Ratings based on tests and procedures performed in accordance with AMCA 500-L and complying with the AMCA 511 Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance, water penetration and wind driven rain ratings.

A. Product Qualifications:

1. Miami-Dade County, Florida Notice of Acceptance (NOA).

2. Florida Building Code Approval.

3. Louver shall be certified to Florida Building Code Testing Application Standards TAS 100(A) (Wind Driven Rain Resistance), TAS 201 (Large Missile Impact), TAS 202 (Uniform Static Air Pressure) and TAS 203 (Cyclic Wind Loading).

4. AMCA Listed for compliance to AMCA 540 Level E and AMCA 550 standards.

1.06 Approval Submittals:

A. Product data: Submit manufacturer's technical product data for louvers including: model number, accessories furnished, construction, finish, mounting details, performance data.

1.07 O&M Data Submittals: Submit maintenance data, including cleaning of finishes and a copy of approval submittals. Include in O&M manual.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers: Subject to compliance with requirements, submit products by Ruskin, Greenheck, Arrow, American Warming and Ventilating, Nailor Industries, or AMCA labeled approved equal.

2.02 General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as

indicated, and as required for complete installation. Provide Kynar 500 coated, corrosion resistant finish and 5 year warranty; color to be selected by the Owner.

2.03 Substrate Compatibility: Provide louvers with 9 inch flanged frame, flange and sill extension piece that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver. Coordinate frame type with architect.

2.04 Materials: Construct of aluminum extrusions, Alloy 6063-T6 0.081" thick for frame and 0.081" thick for front blades and 0.060" thick for back blades. Weld units or use stainless steel fasteners.

2.05 Sill Flashing: Formed aluminum, 0.080" thick, upturned sides to prevent water leakage.

2.06 Installation Angles: Material: 1.375 x 2.25 inch x 0.125 inch thick continuous aluminum angles around louver perimeter for installation in concrete, deep CMU, steel and wood substrate wall systems.

2.07 Installation Plates: Material: 0.250 inch (6.4 mm) thick continuous aluminum flat or zee plates for installation in thin CMU substrate wall systems.

2.08 Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

2.09 Stationary Louvers: Hurricane and impact rated louvers, basis of design is Greenheck EHV-901D.

A. Performance Data:

1. Performance Ratings: AMCA licensed.

    a. Based on testing 48 inches x 48 inches size unit in accordance with AMCA 500-L.

2. Free Area: 42 percent, nominal.

3. Free Area Size: 6.66 square feet.

4. Maximum Recommended Air Flow through Free Area: 2,155 feet per minute.

5. Air Flow: 10,431 cubic feet per minute.

6. Maximum Pressure Drop (Intake): 0.60 inches w.g..

7. Water Penetration: Beginning point of water penetration of 0.01 ounce per ft^2 of free area shall be above 1,250 feet per minute free area velocity.

8. Wind Load Rating: Maximum wind load of ±150 PSF.

9. AMCA 500-L Wind Driven Rain Performance: 99.9 percent effective at preventing water penetration through louver when tested at 50 miles per hour wind with 8 inches per hour rainfall and 2,155 feet per minute airflow through the free

area. Penetration Class ‘A’ with Discharge Class (Intake) ‘3’ in accordance with AMCA 500-L Wind Driven Rain Test.

PART 3 EXECUTION

3.01 Install where shown on the drawings in accordance with the manufacturer's printed instruction and Florida Product Approval. Exercise care to prevent scratches.

3.02 Isolate dissimilar metals per the manufacturer’s recommendations.

3.03 Verify size of louvers shown on drawings prior to fabrication. Coordinate with wall openings. Sizes may be altered subject to approval by Engineer provided free area remains approximately the same as indicated.

END OF SECTION 23 37 26

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SECTION 23 43 18 - BI POLAR IONIZATION AIR CLEANING EQUIPMENT

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of air cleaning work required by this section is indicated on drawings and schedules, and by requirements of this section.

1.4 Refer to Division-23 air handling units section for filter boxes associated with air handling units; not work of this section.

1.5 Refer to Division-23 duct accessories section for duct access door work required in conjunction with air filters; not work of this section.

1.6 Refer to Division-26 sections for power supply wiring from power source to power connection on air filter units. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed by manufacturer.

1.7 Control wiring specified as work of Division 15 for Automatic Temperature Controls is work of that section.

1.8 Codes and Standards:

1.8.1 NFPA Compliance: Comply with applicable portions of NFPA 90A pertaining to installation of air filters.

1.8.2 UL Compliance: Comply with UL Standards pertaining to safety and performance of air filter units.

1.8.3 ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing, and for recording and calculating air flow rates.

1.9 Approval Submittals:

1.9.1 Product Data: Submit manufacturer's technical product data including dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, fire classification, and installation instructions.

BiPolar Ionization

1.9.2 Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, materials, and methods of assembly of components.

BiPolar Ionization

1.10 Test Reports and Verification Submittals:

1.10.1 Submit HEPA filter test reports.

1.11 O&M Data Submittals:

1.11.1 Maintenance Data: Submit maintenance data and spare parts lists for each type of filter and rack required. Include this data, product data and a copy of approval submittals in O&M manual.

1.11.2 Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air filter units. Submit manufacturer's ladder-type wiring diagram for control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. Include in O&M manual.

2 PRODUCTS

2.1 BIPOLAR IONIZATION SYSTEM

2.1.1 The Air Purification System shall be a product of an established manufacturer within the USA.

2.1.2 A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

2.1.3 Technologies that do not address gas disassociation such as UV Lights, Powered Particulate Filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. “Plasma” particulate filters shall not be acceptable.

2.1.4 Projects designed using ASHRAE Standard 62, IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled with the technology submitted. The manufacturer shall provide independent test data on a previous installation performed within the last two years and in a similar application, that proves compliance to ASHRAE 62 and the accuracy of the calculations.

2.1.5 The Air Purification System have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. Manufacturers that achieved UL 867 prior to December 21, 2007 and have not been tested in accordance with the newest UL 867 standard with the ozone amendment shall not be acceptable. All manufacturers shall submit their independent UL 867 test data with ozone results to the engineer during the submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.

2.1.6 The maximum allowable ozone concentration per the UL 867-2007 chamber test shall be 0.007 PPM. The maximum peak ozone concentration per the UL 867-2007 peak test as measured 2 inches away from the electronic air cleaner’s output shall be no more than 0.0042 PPM. Manufacturers with ozone output exceeding these ozone values shall not be acceptable.

2.1.7 Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of twelve months after shipment or eighteen months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

2.1.8 General

The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and shall be of the manufacturer specified.

Basis of Design: Global Plasma Solutions

Approved equals by Airgenics, Active Air Solutions, and Plasma Air subject to specification compliance. All other Suppliers of comparable products requesting prior approval shall:

Submit for prior approval in accordance with the requirements of Mechanical General.

In addition, manufacturers submitting for prior approval for Bi-Polar Ionization must as part of the prior approval request provide their ASHRAE 62.1-2007 calculations that prove conformance to the ASHRAE Standard with the reduction of outside air to the scheduled values. A letter on the manufacturer's letterhead requesting prior approval must accompany the request for prior approval stating their calculations are ASHRAE compliant. A third party validation study performed on a previous installation of the same application shall also be included.

Submit independent test data from ETL or UL showing ozone levels produced during the UL 867 ozone chamber test. Manufacturers without this test data shall not be acceptable.

2.1.9 Bi-Polar Ionization Design & Performance Criteria: Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.

2.1.10 The Bi-polar Ionization system shall be capable of:

Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).

Controlling gas phase contaminants generated from human occupants, building structure and furnishings.

Capable of reducing static space charges.

Increasing the interior ion levels, both positive and negative, to a minimum of 800 ions/cm^3 measured 5 feet from the floor.

2.1.11 The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable.

Air exchange rates may vary through the full operating range of a constant volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.

Velocity Profile: The air purification device shall not have maximum velocity profile.

2.1.12 Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.

2.1.13 Equipment Requirements:

Electrode Specifications (Bi-polar Ionization):

Each Plasma Generator with Bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. A minimum of one electrode pair per 2400 CFM of air flow shall be provided. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion.

Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating. Internal circuitry shall be provided to sense air flow across the electrode output. Ionization systems requiring the use of a mechanical air pressure switch to cycle the electrodes only when the fan is operating shall not be acceptable due to high failure rates and pressure sensitivity.

2.1.14 Air Handler Mounted Units: Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the AHU control power (24VAC) as instructed by the Air Purification Manufacturer's instructions or line voltage subject to power available. Each unit shall be designed with a stainless steel casing, integral illuminated on/off switch, two 2.5mm DC power jacks, high voltage output indication light and dry contacts to prove ion output is operating properly. The dry contacts shall close to prove the ion generator is working properly and may be daisy chained in series such that only one dry contact per AHU is required to interface to the BAS or the optional DDC controller. Dry contacts proving power has been applied in lieu of the ion output is actually operating, are not acceptable.

2.1.15 Ionization Requirements: Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by DC power or 24VAC or 110VAC to 240VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.

Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable.

Ionization output from each electrode shall be a minimum of 15 million ions/cc when tested at 2" from the ionization generator.

All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:

MRSA - >96% in 30 minutes or less
E.coli - > 99% in 15 minutes or less
TB - > 69% in 60 minutes or less

Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELEC accredited independent lab confirming kill rates and time meeting the minimum requirements stated in section 2.2 B, points 6A, 6B and 6C. Products tested only on Petri dishes to prove kill rates shall not be acceptable.

2.1.16 Ozone Generation: The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation. There shall be no ozone generation during any operating condition, with or without airflow.

2.1.17 Electrical Requirements: Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 24 VAC or 100 VAC to 240VAC, 1 phase, 50/60 Hz.

2.1.18 The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.

2.1.19 Control Requirements:

All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.

Integral airflow sensing shall modulate the Plasma output as the air flow varies or stops.

A mechanical air flow switch shall not be acceptable as a means to activate the Plasma device due to high failure rates and possible pressure reversal.

The installing contractor shall mount and wire the Plasma device within the air handling unit specified or as shown or the plans. The contractor shall follow all manufacturer IOM instructions during installation.

3 EXECUTION

3.1 General: Comply with installation requirements as specified elsewhere in these specifications pertaining to air filters housing/casings, and associated supporting devices.

3.2 AIR PURIFICATION SYSTEM

3.2.1 General: The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.2.2 Assembly & Erection: Plasma Generator With Bi-Polar Ionization

All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and engineer.

Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.

All equipment shall be protected from dust and damage on a daily basis throughout construction.

3.2.3 Testing: Provide the manufacturers recommended electrical tests.

3.2.4 Commissioning & Training: A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

3.3 Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer. Verify that

electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-21 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

END OF SECTION 23 43 18

SECTION 23 81 14 - PACKAGED THRU THE WALL AIR CONDITIONING UNITS

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.3 Extent of thru the wall air conditioning unit work required by this section is indicated on drawings and schedules, and by requirements of this section. This section includes straight cool air conditioning units and heat pumps as scheduled on the drawings.

1.4 Refer to Division-26 sections for electrical; not work of this section.

1.5 Refer to other Division-23 sections for testing, adjusting, and balancing of air conditioning units; not work of this section.

1.6 Approval Submittals:

1.6.1 Product Data: Submit manufacturer's technical product data, including dimensions, ratings, electrical characteristics, weight, capacities, materials of construction, and installation instructions. Submit manufacturer's assembly-type drawings showing all piping and electrical connections and all mounting requirements. Show methods of fastening and assembly of components. Provide wiring diagrams.

1.6.2 O&M Data Submittals: Submit manufacturer's maintenance data including parts lists. Include these data, product data, and a copy of approval submittals in O&M manual.

2 PRODUCTS

2.1 Quality Assurance:

2.1.1 Test and rate thru the wall units in accordance with ARI Standard 390 and provide certified rating seal.

2.1.2 Construct refrigeration system in accordance with ASHRAE 15 (ANSI B 9.1) "Safety Code for Mechanical Refrigeration".

2.1.3 Provide thru the wall units that are designed, manufactured, tested, and listed in accordance with ETL requirements.

2.1.4 Provide thru the wall units with an EER, IPLV, and COP that meet the requirements of the Florida Energy Efficiency Code and the schedules on the drawings.

2.1.5 Acceptable Manufacturers: Subject to compliance with requirements, provide thru the wall units by Bard, Marvair, Eubank, or approved equal.

2.2 General:

2.2.1 Casings: Construct of heavy gauge mill galvanized steel (or aluminum) formed panels rigidly reinforced and braced. Each unit shall be provided with removable panels to permit the unit (including fans and compressors) to be properly maintained and serviced. Entire casing to be zinc phosphatized and finished with baked enamel. Provide color selected by owner. Casing shall be weatherproofed. Provide mounting brackets.

2.3 Condensing Section:

2.3.1 Condenser Fans and Drives: Fan shall be of rustproof construction. Unit shall have weather protected motor. Provide a close fretwork galvanized steel or non-ferrous fan guard. Motors shall be the permanently lubricated type, resiliently mounted.

2.3.2 Condenser Coil: Construct of non-ferrous tubes and aluminum fins with factory or field applied seacoast coating. Coating shall be applied after fins have been punched or stamped so that no exposed aluminum edges exist. Provide inlet guard to protect condenser fins.

2.3.3 Compressor: Shall be high efficiency two stage scroll with step capacity providing two stages of control in cooling and heating with vibration isolation. Compressor shall be designed for R410a refrigerant. Compressor shall be attached to a double isolated floating mounting system and include a sound blanket and discharge muffler. Motors shall be specifically designed for compressor service. Compressor shall not produce objectionable noise or vibration inside the building. Compressors shall have five (5) year warranty.

2.3.4 Service Valves: Provide for high and low pressure readings.

2.3.5 Provide filter dryer.

2.4 Evaporator Section:

2.4.1 Interior of unit shall be thermally and acoustically insulated with 1" indoor air quality fiberglass duct liner insulation. Provide removable panels to permit the unit to be properly serviced and maintained.

2.4.2 The evaporator section shall consist of an insulated air handling unit cabinet constructed of heavy gauge steel. The unit shall include centrifugal fan, direct drive fan motor, cooling and heating coil, 2" thick filters selected for a maximum velocity of 500 fpm, thermostatic expansion valve, controls and other necessary devices for a completely automatic unit. Coils shall have non-ferrous tubes and aluminum fins. Provide factory or field applied seacoast coil coating applied after fins have been punched or stamped so that no exposed aluminum edges exist. Provide outdoor air intake with hood and manual damper.

2.4.3 Evaporator Fan: Provide high efficiency ECM motor. Motor shall include soft start and shall be self-adjusting to provide proper airflow at varying static pressure. Blower wheels shall be curved blades.

2.5 Electric Heater Section:

2.5.1 Provide electric heating coil controlled by one or more magnetic contactors. Three phase coils shall be wired for balanced current in each wire, if possible. Furnish and install necessary overheating and air flow controls to meet the requirements of the National Electric Code. Provide built-in air flow switch and heater interlock relay.

2.5.2 Heaters shall be factory mounted and wired with all required fuses and contactors to provide single point connection.

2.6 Ventilation:

2.6.1 Provide internally mounted ventilator intake and built in exhaust damper. Provide motorized damper with spring return to closed position.

2.7 Hot Gas Reheat:

2.7.1 Provide factory installed hot gas reheat coil sized to nominally match the sensible cooling capacity of the evaporator coil. Provide solid state circuit board for control of the dehumidification function. Electric heat shall be locked out during dehumidification mode.

2.8 Controls:

2.8.1 All safety and operational controls shall be factory wired. Refer to Mechanical Controls Sheets for sequence of operation and additional requirements.

2.8.2 Safety and Operational Control Features:

Internal compressor over-temperature protection.
Individual motor overcurrent protection.
High pressure cutout.
Low temperature cutout.
Timer-type defrost control.
Anti-recycle time delay start.
Phase failure and low voltage protection.
Circuit breaker.

2.9 Warranty: Provide 5 year parts warranty for the entire unit.

2.10 Equipment Coating: Provide clear inorganic reacted siloxane coating over all surfaces of the unit exposed to the outdoors, MicroGuard AD35 by Adsil or equal. Completely coat condenser coils, base pan, cabinet, and all exposed refrigerant parts, covers, and shields. Provide 6 to 8 micron dry film thickness and all cleaning, prep, and finish work required for first class installation. Provide 3 year warranty on the coating. Provide 72 hour notice to engineer for witnessing of field applied coatings.

3 EXECUTION

3.1 Installation: Install in accordance with producer's printed instructions. Anchor housing to building with cadmium plated self-tapping screws, lag screws, or bolts, as directed by specific construction and manufacturer. All mounting supports shall be provided by Division-23. Care must be taken to maintain the integrity of factory or field applied corrosion protection coatings. Coatings that are damaged during installation shall be repaired to match the specified coating.

3.2 Cleaning: Clean tar and all other soil from housing exterior. Leave ready for Division 7, Caulking Work. Coordinate with general construction to ensure a water-tight seal.

3.3 Condensate Drain: Pipe copper condensate drain to the point of disposal as shown on the

drawings. Pipe shall be full size of unit outlet. Refer to Division-23 section "Insulation" for pipe insulation.

3.4 Startup: Check entire assembly for correctness of installation, alignment, and control sequencing. Start all component parts in proper sequence. Make all adjustments required to insure proper smooth quiet operation.

END OF SECTION

SECTION 23 81 28 - DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 GENERAL

1.01 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.03 Refer to other Division-23 sections for testing, adjusting, and balancing of units; not work of this section.

1.04 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data, including dimensions, ratings, electrical characteristics, weight, capacities, materials of construction, and installation instructions. Submit assembly-type drawings showing all piping and electrical connections and all mounting requirements. Show methods of fastening and assembly of components. Provide wiring diagrams.

1.05 O&M Data Submittals: Submit manufacturer's maintenance data including parts lists. Include these data, product data, and a copy of approval submittals in O&M manual.

PART 2 PRODUCTS

2.01 Quality Assurance:

A. Test and rate split system air conditioning units in accordance with ARI Standard 210, 240 or 360 as applicable, and provide certified rating seal.

B. Construct refrigeration system of split system air conditioning units in accordance with ASHRAE 15 (ANSI B 9.1) "Safety Code for Mechanical Refrigeration".

C. Provide split system air conditioning units with an SEER that meets the Florida Energy Efficiency Code and the schedule on the drawings.

D. Provide split system air conditioning units that are designed, manufactured, and tested in accordance with UL or ETL requirements.

E. Acceptable Manufacturers: Submit to compliance with requirements, provide units by Daikin, Sanyo, Toshiba, Mitsubishi, or approved equal.

2.02 General:

A. Casings: Construct of painted mill galvanized steel (or aluminum) formed panels rigidly reinforced and braced. Each unit shall be provided with removable panels to permit the unit (including fans and compressors) to be properly maintained and serviced.

2.03 Condensing Unit:

A. Condenser Fans and Drives: Fan shall be of rustproof construction, hot dipped galvanized steel, stainless steel or aluminum. Unit shall have weather protected totally enclosed motor. Provide a close fretwork galvanized steel or non-ferrous fan guard. Motors shall be the permanently lubricated type, resiliently mounted.

B. Condenser Coil: Construct of non-ferrous tubes and aluminum fins. Provide inlet guard to protect condenser fins. Provide seacoast coating on coils.

C. Compressor: Shall be scroll or hermetic design with vibration isolation. Compressor shall not produce objectionable noise or vibration inside the building. Compressors shall have five (5) year warranty.

D. Service Valves: Provide for high and low pressure readings.

2.04 Evaporator Unit:

A. Interior of unit shall be thermally and acoustically insulated with 1 inch fiberglass duct liner insulation. Provide removable panels to permit the unit to be properly serviced and maintained.

B. The evaporator section shall include centrifugal fan, two-speed fan motor, and direct drive. Provide cooling coil, snap out washable filters, refrigerant drier, controls and other necessary devices for a completely automatic unit. Coils shall have copper tubes and aluminum fins. Provide automatic oscillating louver action to facilitate air distribution.

2.05 Controls:

A. All safety and operational controls shall be factory wired.

B. Provide remote microprocessor-based controls with room thermostat, timer and fan speed switch.

2.06 Refrigerant Piping:

A. Copper tubing 3/4" and smaller: Type ACR, soft annealed temper; cast copper-alloy fittings for flared copper tubes; flared joints.

B. Brazing material: Silver solder bearing at least 15% silver; Sil Fos.

PART 3 EXECUTION

3.01 Installation: Install in accordance with producer's printed instructions.

3.02 Refrigerant Piping: Comply with ANSI B31.5, "Refrigerant Piping," (extend lower pressure limits below 15 psig), and ASHRAE 15 (ANSI B9.1). Make all joints carefully and neatly. Clean pipe and fittings before fluxing. Remove burrs. Braze by the sweat method using Sil Fos.

3.03 Testing: After job erection, pressure test for leaks at 150 psig using a nominal amount of a suitable tracer refrigerant and dry nitrogen or a suitable refrigerant. Perform leak tests with an electronic halide leak detector having a sensitivity of at least 1/2 ounce R-12 per year. Refrigeration piping will not be accepted unless it is gas tight.

3.04 Evacuation: After completing the successful pressure test, multiple-evacuate the system. Leave the compressor isolation valves shut and connect the vacuum pump to both the high and low sides. Evacuate the system to an absolute pressure of 1,500 microns. Then break vacuum to 2 psig with dry nitrogen. Repeat this process. Install the proper biflow drier in the liquid line and evacuate the system to 500 microns. Leave vacuum pump running for at least two hours without interruption. Break vacuum with the refrigerant to be used and raise pressure to 2 psig. Do not operate compressors during the evacuation procedure.

3.05 Charging: After completing the successful evacuation procedure, charge refrigerant directly to the system from the original containers through a filter drier. Charge to the manufacturer's stated conditions of pressure for required temperature. Weigh the refrigerant added and record on the startup report.

3.06 Cleaning: Clean tar and all other soil from housing exterior. Leave ready for Division 7, Caulking Work. Caulk around pipe sleeves.

3.07 Condensate Drain: Pipe trapped copper condensate drain to outside the building or to a point of disposal as shown on the drawings. Pipe shall be full size of unit outlet. Refer to Division-23 section "Insulation" for pipe insulation.

3.08 Startup: Check entire assembly for correctness of installation, alignment, and control sequencing. Start all component parts in proper sequence. Make all adjustments required to insure proper smooth quiet operation.

END OF SECTION 23 81 28

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