

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

- A. The intent of Division 23, HVAC Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include work specified in Division 23, HVAC and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.
- B. The Drawings that accompany the Division 23, HVAC Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.
- C. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and specifications.
 - 2. Public ordinances, permits.
 - 3. Include payments and fees required by governing authorities for work of this Division.
- D. Division 01, General Requirements, General Requirements, applies to this Division.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Products and equipment prohibited from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
 - 2. General: Work and materials conforms to the local and State codes, and Federal, State and other applicable laws and regulations.
 - 3. Contractor responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.
- B. New materials and equipment. Work of good quality, free of faults and defects and in conformance with the Contract Documents.
- C. Apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- D. The entire mechanical system and apparatus operates at full capacity without objectionable noise or vibration.
- E. Install equipment level and true. Housekeeping pads and curbs account for floor or roof slope.

F. Materials and Equipment:

1. Each piece of equipment furnished meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting requirements will not be acceptable, even though specified by name along with other manufacturers.
2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
3. Furnish materials and equipment of size, make, type, and quality herein specified.
4. Equipment scheduled by performance or model number considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements, or any other differences which impact the project.

G. Workmanship:

1. General: Install materials in a neat and professional manner.
2. Manufacturer's Instructions:
 - a. Follow manufacturer's directions where they cover points not specifically indicated.
 - b. If conflict with the Drawings and Division 23, HVAC Specifications, obtain clarification before starting work.

H. Cutting and Patching:

1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Do not pierce beams or columns without permission of Architect and then only as directed.
5. Restore new or existing work cut or damaged to its original condition. Where alterations disturb lawns, paving, walks, etc., surfaces repaired, refinished, and left in condition existing prior to commencement of work.

1.04 SUBMITTALS

A. Shop Drawings:

1. The Contract Drawings indicate the general layout of the piping, ductwork, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of piping, ductwork, and equipment installations. Shop Drawings new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. Drawings the same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. Drawings fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.

2. Prepare in two-dimensional format.
3. Include but are not limited to:
 - a. Complete floor plans with sheet metal and HVAC piping to a minimum of 1/4-inch equals 1-foot scale.
 - b. Sheet metal and HVAC piping of mechanical and fan rooms to a minimum of 1/2-inch equals 1-foot scale.
 - c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
 - d. Controls and Instrumentation: Scale and drawing sizes to suit controls supplier.
 - e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment not less than 1/4-inch equals 1-foot scale.
 - f. Superplot plans of above ground work with a colored overlay of trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.
 - g. Superplot plans of below ground work with a colored overlay of trades including, but not limited to, structural footings and foundation, HVAC piping, civil piping, plumbing piping, and power conduit to a minimum of 1/2-inch equals 1-foot scale.
 - h. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.
 - i. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.
 - j. Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.
4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:

1. In general, submit product data for review on scheduled pieces of equipment, on equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications, and data sheets. Data sheets include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.
4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:

1. Shop Drawings and Product Data:

- a. Refer to Division 01, General Requirements for additional requirements related to submittals.
- b. Submit copies of shop drawings and product data for Work of Division 23, HVAC in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, Article and paragraph, and mark if applicable.
- c. Submit electronic copies of shop drawings and product data for Work of Division 23, HVAC in PDF format with each item filed under a folder and labeled with its respective specification section number, Article and paragraph and mark if applicable.
- d. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
- e. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, included with the original submittal. Controls and Instrumentation submittals may lag but complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

D. Contractor Responsibilities:

1. Submit submittals one time and are in proper order.
2. Ensure that equipment will fit in the space provided.
3. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.05 AS-BUILT DRAWINGS

- A. Provide 3D model and record drawings at the end of the project on CD-ROM.
- B. 3D model in the following format:
 1. AutoCAD
- C. Record Drawings: Provide hard copies and pdf format.
 1. Drawings include the following:
 - a. Project Specific Titleblock.
 - b. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.

1.06 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNER'S INSTRUCTIONS

- A. Refer to Division 01, General Requirements for additional requirements.
- B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature on 8-1/2-inch by 11-inch sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for electrically powered equipment.

- C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover phases of control.
- D. Furnish competent engineer knowledgeable in this building system for minimum of five 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Keep a log of this instruction including dates, times, subjects, and those present and present such log when requested by Architect.

1.07 PROJECT CONDITIONS

- A. Existing Conditions:
 - 1. Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work.
 - 2. Include related costs in the initial bid proposal.
- B. Coordinate exact requirements governed by actual job conditions. Check information and report discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, the City, and Utility Company.

1.08 WARRANTY

- A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.
- B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.
- C. Correct warranty items promptly upon notification.

1.09 PROVISIONS FOR LARGE EQUIPMENT

- A. Make provisions for the necessary openings in building to allow for admittance of equipment.

1.10 TEST REPORTS AND CERTIFICATES

- A. Submit one copy of test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

- A. Submit requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 – PRODUCTS

2.01 ACCESS PANELS

- A. Furnish under this Division as specified in another Division of work.

2.02 PIPE AND DUCT SLEEVES

- A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.
- B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.
- C. Exterior Wall Sleeves: Cast iron
- D. On Grade Floor Sleeves: Same as exterior wall sleeves.
- E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.03 FLOOR, WALL AND CEILING PLATES

- A. Furnish stamped split type plates as follows:
 - 1. Floor Plates: Cast brass, chromium plated.
 - 2. Wall and Ceiling Plates: Spun aluminum.

2.04 MACHINERY GUARDS

- A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.
- B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.
- C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards easily removable for pulley adjustment or removal and changing of belts.
- D. Guards meet OSHA requirements including back plates.
- E. Provide inlet and outlet screens on fans in plenums or where exposed to personnel.

2.05 ELECTRICAL EQUIPMENT

- A. General: Equipment and installed work as specified under Division 26, Electrical.
- B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available fault current rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment with a Short Circuit Current Rating (SCCR) that meets the bracing requirement.
- C. Motors – AC Induction:
 - 1. Furnish as integral part of driven equipment.
 - 2. Drip proof induction type with ball bearings unless noted otherwise.
 - 3. Motors 1 hp and above premium energy efficient type, except for emergency equipment motors.
 - 4. Built to NEMA Standards for the service intended.
 - 5. Rated for voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.
 - 6. Energy Efficient Motors:
 - a. Baldor
 - b. Westinghouse
 - c. General Electric
 - d. Or approved equal.
 - 7. Motors meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	KW	900	1200	1800	3600
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5
7.5	5.6	87.5	91.7	91.7	91.0
10	7.5	88.5	91.7	91.7	91.7
15	7.5	88.5	91.7	92.4	91.7
20	15.9	90.2	92.4	93.0	92.4
25	18.8	91.0	93.0	93.6	93.0

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	KW	900	1200	1800	3600
30	22.5	91.0	93.6	94.1	93.0
40	30.0	91.7	94.1	94.5	93.6
50	37.5	92.4	94.1	94.5	94.1
60	45.0	93.0	94.5	95.0	94.1
75	56.3	93.0	95.0	95.4	94.5
100	75.0	93.0	95.4	95.4	95.0
125	93.8	94.5	95.4	95.4	95.4
150	112.5	94.5	95.8	95.8	95.4
200	150.0	94.5	95.8	96.2	95.8
250	187.5	94.5	95.1	96.2	95.1
300	225.0	94.5	95.3	96.2	95.3
350	225.0	94.5	95.3	96.2	95.3
400	300.0	94.5	95.4	96.2	95.4
450	337.5	94.5	95.5	96.2	95.5
500	375.0	94.5	95.6	96.2	95.6

8. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
 9. Refer to individual product sections for additional motor requirements.
 10. Furnish motors on belt drive equipment of nominal nameplate horsepower not less than 120 percent of equipment brake horsepower required for performance specified.
 11. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.
 12. Motors controlled by variable frequency drives inverter duty rated and have Class F insulation or better. Withstand repeated voltage peaks of 1600V with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
 13. Motors served from variable frequency drives equipped with shaft grounding system which provide a path for current to flow between the shaft and motor frame. SGS or equal.
- D. Motors – Electronic Commutation (EC):
1. Furnished as integral part of driven equipment.
 2. Permanently lubricated with ball bearings unless noted otherwise.
 3. Internal motor circuitry converts AC power supplied to the motor to DC power to operate the motor.
 4. Speed controllable down to 20 percent of full speed.
 5. Motor efficiency at a minimum of 85 percent at all speeds.
 6. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
 7. Refer to individual product sections for additional motor requirements.
 8. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Quick trip devices hermetically sealed motors.

- 9. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.
- E. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.
- F. Equipment Wiring:
 - 1. Interconnecting wiring within or on a piece of mechanical equipment provided with the equipment unless shown otherwise.
 - 2. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.
- G. Control Wiring: Control wiring for mechanical equipment provided under Section 23 09 00, Instrumentation and Controls for HVAC.
- H. Codes: Electrical equipment and products bear the UL label as required by governing codes and ordinances.

PART 3 – EXECUTION

3.01 ACCESS PANELS

- A. Install in accord with manufacturer's recommendations, coordinated with architectural features.
- B. Provide 2-hour fire rated doors where required bearing the UL label.
- C. Furnish 18-inch by 18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.
- D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.02 SLEEVES

- A. Interior Floor and Wall Sleeves:
 - 1. Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork.
 - 2. Where pipe or ductwork is insulated, provide sleeve large enough to provide 3/4-inch clearance around insulation. Maintain continuous insulation as it passes through sleeve.
 - 3. Penetrations through mechanical room and fan room floors watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.
- B. Sleeves through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping or duct material, size and service.
- C. Sleeves specified or indicated at fire damper penetrations take precedence over this article.
- D. Exterior Wall Sleeves Below Grade:
 - 1. Provide water tight sleeves. Install at pipes entering building below grade and where shown.
 - 2. Adjust to provide positive hydrostatic seal.
 - 3. Follow manufacturer's procedure for installing and tightening seal.
 - 4. Secure sleeves against displacement.

- E. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.
- F. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.
- G. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.
- H. Floor sleeves maintain a water barrier by providing a water tight seal or they extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated.
- I. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members provided so pipes are floor supported.
- J. Special sleeves detailed on drawings take precedence over this section.

3.03 CLEANING

- A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.
- B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.
- C. Additional requirements are specified under specific Sections of this Division.

3.04 EQUIPMENT PROTECTION

- A. Keep pipe, ductwork, and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment, and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.
- B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.
- C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.05 ACCESSIBILITY

- A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.
- B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms, and walkways.

3.06 FLOOR, WALL, AND CEILING PLATES

- A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe and duct.
- B. Secure wall and ceiling plates to pipe, insulation, or structure.
- C. Plates not penetrate insulation vapor barriers.
- D. Plates not required in mechanical rooms or unfinished spaces.

3.07 PAINTING

- A. General:
 - 1. Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.

2. Exposed work under this Division receives either a factory painted finish or a field prime coat finish, except:
 - a. Exposed copper piping.
 - b. Aluminum jacketed outdoor insulated piping.
- B. Equipment Rooms and Finished Areas:
 1. Insulation: Not painted.
 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
 3. Steel Valve Bodies and Bonnets: One coat of black enamel.
 4. Brass Valve Bodies: Not painted.
 5. Equipment:
 - a. One coat of grey machinery enamel.
 - b. Do not paint nameplates.
 6. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers, and registers flat black.
- C. Concealed Spaces (above ceilings, not visible):
 1. Insulation: Not painted.
 2. Do not paint the following:
 - a. Hangers
 - b. Uninsulated Piping
 - c. Miscellaneous Iron Work
 - d. Valve Bodies and Bonnets
- D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.
- E. Roof Mounted Equipment:
 1. Paint two coats of exterior machinery enamel.
 2. Color as selected by Architect.
 3. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.
- F. Exterior Black Steel Pipe:
 1. Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel.
 2. Painting schemes comply with ANSI A13.1.

3.08 ADJUSTING AND CLEANING

- A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.
- B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.09 ELECTRICAL EQUIPMENT

- A. Ductwork or piping for mechanical systems not serving electrical space not installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.
- B. Ductwork or piping for mechanical systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

- A. Make final connections to equipment specified in sections other than Division 23, HVAC of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.
- B. Piping:
 - 1. Connections include steam supply, steam vent, and condensate.
 - 2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
 - 3. Independently support piping connections supported to prevent undue strain on equipment.
- C. Ductwork: Make exhaust connections to fume hoods, emergency generator radiators, and any other processing, laboratory, or kitchen equipment in strict accordance with manufacturer's instructions.
- D. Engine Exhaust: Make connections as necessary for complete working installation to the emergency generators as indicated and specified.
- E. Refer to Division 11, Equipment for requirements.

END OF SECTION

SECTION 23 05 23

GENERAL DUTY VALVES AND SPECIALTIES FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Ball Valves
 - 2. Balancing Valve HVAC Option A
 - 3. Automatic Flow Control Valves HVAC Option C
 - 4. Specialty Valves
 - 5. System Specialties

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

- A. Submit product data.
- B. Submit balancing valve schedule with manufacturer, model, size, flow rate and pressure drop.
- C. Submit automatic flow control valve schedule with manufacturer, model, size, flow rate and pressure drop.

PART 2 – PRODUCTS

2.01 MANUFACTURER

- A. General: Where only NIBCO figure numbers are listed, equivalent products by those specified below are acceptable.
- B. Ball Valves:
 - 1. Gruvlok
 - 2. Apollo
 - 3. Crane
 - 4. Hammond
 - 5. Milwaukee
 - 6. Victaulic
- C. Balancing Valve:
 - 1. DeZurik
 - 2. Homestead
 - 3. Bell and Gossett
 - 4. Armstrong
 - 5. Walworth
 - 6. Taco
 - 7. Wheatley
 - 8. Tour & Andersson
 - 9. Victaulic
 - 10. Gruvlok

- 11. NIBCO
- D. Automatic Flow Control Valves:
 - 1. Griswold
 - 2. Flow Design
 - 3. Or approved equal.
- E. Specialty Valves:
 - 1. Drain Valves:
 - a. Gruvlok
 - b. Apollo
 - c. Crane
 - d. Hammond
 - e. Milwaukee
 - f. Victaulic
 - g. Or approved equal.
- F. System Specialties:
 - 1. Manual Air Vents:
 - a. Coin type
 - b. Dole 9
 - c. Or approved equal.
 - 2. Pressure/Temperature Test Plug:
 - a. Peterson Engineering, Inc.
 - b. Universal Lancaster
 - c. Sisco
 - d. Trerice
 - e. Or approved equal.
- G. Use one manufacturer on valves.
- H. Threaded, flanged, soldered, or grooved valve ends, as applicable to piping system. Refer to Section 23 21 13, Pipe and Pipe Fittings HVAC for allowable fittings.

2.02 BALL VALVES

- A. Bronze Ball: Bronze cast body or forged brass, chrome-plated full port ball, with handle, Teflon seat, 300 psi WOG, 150 psi steam; NIBCO 585-70 or Victaulic Series 589.

2.03 BALANCING VALVE

- A. Calibrated:
 - 1. Bronze, Ametal (copper-alloy), or ductile iron body, brass globe or ball, differential pressure readout valves with integral checks, calibrated plate, integral pointer, suitable for tight shutoff, memory stops, threaded, grooved, or soldered ends, 250 psi water; Victaulic, Tour Anderson, Bell and Gossett CB.
 - 2. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.
- B. Eccentric Plug:
 - 1. Cast iron body, EPT coated plug, pressure measuring ports, flanged or grooved cut end, memory stop, 2-inch square actuating nut for sizes up to 6-inch, above 6-inch gear operator, 175 psi; Victaulic Series 365 or DeZurik 118-F.

2. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

2.04 AUTOMATIC FLOW CONTROL VALVES

- A. Furnish automatic pressure compensating flow control valves.
- B. Valves factory set and calibrated within 5 percent of indicated water flow rate. Provide taps for measuring of flows with quick disconnect valves.
- C. Field adjustable flow rate with adjustable flow control cartridge.
- D. Provide identification tags for each valve indicating type, flow characteristics, etc.
- E. Pressure range of 1-14 psig.
- F. 150 psi operating pressure.
- G. Provide strainers and isolation valves separately from flow control valves, where required.
- H. Size flow control valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

2.05 SPECIALTY VALVES

- A. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap, and chain 3/4-inch size.

2.06 SYSTEM SPECIALTIES

- A. Temperature and Pressure Test Plugs:
 1. General: 1/2-inch N.P.T. fitting to receive either a temperature or pressure probe 1/8-inch O.D., fitted with a color coded and marked cap with gasket.
 2. Material: Solid brass with valve core of NORDEL.
 3. Rating: Minimum 300 psig at 275 degrees F.
 4. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch O.D. probe and two five-inch stem pocket test thermometers 25 degrees -125 degrees F for chilled water, 40 degrees -240 degrees F for heating water.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Provide valves at connections to equipment where shown or required for equipment isolation.
- B. Install valves and strainers in accessible locations and same size as connected piping (not the size of the equipment connection), except balancing valves sized by contractor to properly balance the flow.
- C. Provide separate support for valves where necessary.
- D. Provide drain valves in low points in the piping system, at coils and equipment, and as indicated.

3.02 APPLIED LOCATIONS HVAC VALVES

- A. Piping 2-inches and Smaller:

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Heating Water	At Boiler Only	Bronze	Bronze	Bronze	Not Allowed

- B. Calibrated balancing valves 2-1/2-inch and smaller, on water coils and in piping systems in accordance with manufacturer's recommendations.

- C. Eccentric Plug Valves 3-inch and larger, on water coils and in piping systems in accordance with manufacturer's recommendations.
- D. Automatic flow control valves on water coils and in piping systems in accordance with manufacturer's recommendations to automatically balance water flow in piping loops as indicated.
- E. Provide gauge cock for pressure gauges.

3.03 VALVE IDENTIFICATION

- A. General: Identify valves to indicate their function and system served.
- B. See Section 23 05 53, Identification for HVAC Piping and Equipment.

3.04 INSTALLATION

- A. Manual Air Vents:
 - 1. Install at high points where automatic air vents are not used, where noted, and where required for proper venting of system.
 - 2. Install in accordance with manufacturer's recommendations.
- B. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 23 05 29

HANGERS, SUPPORTS, AND ANCHORS FOR HVAC

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, General Requirements Specification Sections, apply to this Section.
- B. The provisions of Division 23, Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes Design-Build work.
- B. This Section includes:
 - 1. Supports
 - 2. Anchors
 - 3. Pipe Rollers
 - 4. Insulation Protection Shields
 - 5. Insulation Protection Saddles
 - 6. Building Attachments

1.03 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 07 00, Insulation for HVAC
- D. Section 23 21 13, Pipe and Pipe Fittings HVAC

1.04 QUALITY ASSURANCE

- A. Provide pipe and equipment hangers and supports in accordance with the following:
 - 1. Design supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork when not shown on the Drawings.
 - 2. Hangers, supports and sway braces to be fabricated in accordance with ANSI B31.1 and MSS SP-58 and SP-89.
 - 3. Use components for intended design purpose only. Do not use for rigging or erection purposes.
 - 4. Seismic restraints and anchorages shall resist seismic forces as specified in the state and local code or by the authority having jurisdiction for the seismic zone in which the project is constructed.
 - 5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
 - 6. Seismic Restraints:
 - a. Shall not introduce stresses in the piping caused by thermal expansion or contraction.
 - b. Shall not exceed forces or design limits of the piping per ASME B31.9.

- c. Provide in accordance with the latest edition of the SMACNA, Seismic Restraint Manual Guidelines for Mechanical Systems” for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
 - d. Provide in accordance with the local applicable codes.
 - e. Follow provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.
- 7. Piping Connections to Equipment:
 - a. Shall not introduce twisting, torsion, or lateral forces or moments on the equipment.
 - b. Shall be supported and isolated in a manner not to exceed the equipment’s point of connection load limitations.
- B. Engineered Support Systems: Provide design services for the following support systems:
 - 1. Supports and seismic restraints for suspended piping, ductwork, and equipment.
 - 2. Support frames such as pipe racks or stanchions for piping, ductwork, and equipment which provide support from below.
 - 3. Equipment, ductwork, and piping support frame anchorage to supporting slab or structure.

1.05 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings of contractor fabricated support structures.
 - 2. Structural Details and Calculations:
 - a. Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
 - b. Details and calculations to bear the seal of a professional engineer registered in the state having jurisdiction.
 - 3. No other submittals required under this section.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Supports:
 - 1. Unistrut
 - 2. Superstrut
 - 3. Powerstrut
 - 4. Kinline
 - 5. B-Line Systems
 - 6. AnvilStrut
- B. Pipe Hangers:
 - 1. Anvil
 - 2. Superstrut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
 - 6. Pipe Shields Inc.

- 7. Rilco
- C. Pipe Rollers
 - 1. Anvil
 - 2. Super Strut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
- D. Insulation Protection Shields
 - 1. Anvil
 - 2. Super Strut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
- E. Insulation Protection Saddles
 - 1. Anvil
 - 2. Super Strut
 - 3. B-Line Systems
 - 4. Tolco
 - 5. ERICO
- F. Building Attachments
 - 1. Anvil
 - 2. Elcen
 - 3. Superstrut
 - 4. B-Line Systems
 - 5. Tolco
 - 6. ERICO

2.02 SUPPORTS

- A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.
- B. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.
- C. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.
- D. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.03 PIPE HANGERS

- A. Uninsulated Horizontal Copper Piping:
 - 1. 2-inch and Smaller: Anvil CT-65, CT-69.
 - 2. Larger than 2-inch:
 - a. Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods.
 - b. Electricians' tape is unacceptable.

- B. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.
- C. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- D. Other Uninsulated Horizontal Pipe:
 - 1. 2-inch and Smaller: Anvil 65, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- E. Other Insulated Horizontal Pipe with Hangers Inside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 104, 260 or 300.
 - 2. Larger than 2-inch: Anvil 260.
- F. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- G. Riser Clamps Copper Pipe:
 - 1. 4-inch and Smaller: Anvil CT-121, CT-261.
 - 2. Larger than 4-inch: Anvil 261.
- H. Riser Clamps Other Piping: Anvil 261.

2.04 PIPE ROLLERS

- A. Cast Iron roll and sockets, steel roll rod.
 - 1. Anvil 171, 175, 177, 178, 181, or 274 as required.
 - 2. Size for pipe plus insulation for insulated pipe.

2.05 INSULATION PROTECTION SHIELDS

- A. Galvanized carbon steel.
 - 1. Anvil 167.

2.06 INSULATION PROTECTION SADDLES

- A. Carbon steel.
 - 1. Anvil 160 series.
 - 2. Saddles for copper pipe: Factory copper plated.

2.07 BUILDING ATTACHMENTS

- A. Beam Hangers:
 - 1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.
 - 2. On piping larger than 6-inch: Anvil 228, or 292.
- B. Inserts:
 - 1. Anvil 152 malleable iron or 281 steel inserts.
 - 2. Inserts sized for required rod to support load being carried.
- C. Expansion Plugs: Similar and equal to Phillips "red-head" self-drilling flush shell selected for safety factor of 4.
- D. Powder actuated fasteners with silencers as approved by Architect.

PART 3 – EXECUTION

3.01 HANGERS AND SUPPORTS

- A. General:
1. Install support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required, and as detailed on the Drawings.
 2. Provide adjustable hangers for pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
 3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. 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.
 4. Except as otherwise indicated for exposed continuous pipe runs, install hangers, and supports of same type and style as installed for adjacent similar piping.
 5. Support piping within 2-feet of each change of direction on both sides of fitting.
- B. Insulated Piping Systems:
1. Refer to Section 23 07 00, Insulation for HVAC for insulation requirements.
 2. Insulated Piping Systems with Vapor Barrier Insulation:
 - a. Install hangers outside of insulation.
 - b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.
 3. Heating Water (over 230 degrees F), Medium Pressure Steam and High Pressure Steam (Non-Vapor Barrier Insulation):
 - a. As specified for Insulated Piping Systems with Vapor Barrier Insulation.
 4. Other insulated Piping Systems with Non-Vapor Barrier Insulation:
 - a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
 - b. If hangers are installed outside of insulation, provide insulation protection shields at support locations on piping 1-1/2-inch and larger.
 - c. On piping larger than 2-inch, provide insulation saddles at each support location.
 5. Insulation Protection:
 - a. Band insulation protection shields firmly to insulation to prevent slippage.
 - b. Tack weld insulation protection saddles to steel pipe. Braze saddles to copper pipe.
- C. Vertical Piping:
1. Support Spacing: Provide support at minimum spacing in accordance with state and local codes.
 2. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
 3. Provide mid-story vertical guide support where floor to floor distances exceed spacing as required by state and local codes. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
 4. Risers that are not subject to thermal change to be supported at each floor of penetration.

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5. Risers that are subject to thermal change require engineered supports. Size supports to carry forces exerted by piping system when in operation. Riser supports follow the provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.
- D. Horizontal Piping:
1. Trapeze Hangers:
 - a. Multiple pipe runs where indicated supported on channels with rust resistant finish.
 - b. Provide necessary rods and supporting steel.
 2. Support Spacing:
 - a. Provide support at maximum spacing in accordance with state and local codes and any applicable manufacturer requirements.
 - b. Support piping within 2-feet of each change in direction.
 - c. Provide piping with acoustical lagging wrap supported a maximum of 5-feet on center. Install hangers outside of acoustical lagging.
- E. Building Attachments:
1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
 2. Provide horizontal bracing on horizontal runs 1-1/2-inch and larger and exceeding 50-feet in length at 75-foot intervals and as required to provide stabilized piping systems.
 3. Provide additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
 4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Valve Identification
 - 2. Piping Markers
 - 3. Equipment Identification
 - 4. Concealed Equipment Identification

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
 - 2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
 - 3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Piping Markers:
 - 1. W.H. Brady
 - 2. Seton
 - 3. Marking Systems, Inc. (MSI)
 - 4. Other Manufacturers: Submit substitution request.
- B. VALVE IDENTIFICATION
- C. Valve Tags:
 - 1. General: Identify valves with metal tags, legends to be stamped or embossed. Indicate the function of the valve and its normal operating position; i.e.,

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)
 - 2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
 - 3. Material: Use 0.04-inch brass tags.
 - 4. Automatic Valves and Regulating Valves:
 - a. Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, lamicaid, or equal.
 - b. Form letters by exposing center ply.
 - 5. Buildings Systems: Contact the Owner for coordination with existing building tagging system and supplementary information required for any specific system before valve tagging begins.

- D. Valve Tag Directory:
1. Tag Number
 2. Location
 3. Exposed or Concealed
 4. Service
 5. Valve Size
 6. Valve Manufacturer
 7. Valve Model Number
 8. Normal Operating Position of Valve

2.02 PIPING MARKERS

- A. Label pipes with all-vinyl, semi-rigid plastic or strap-on labels.
- B. For pipes O.D. smaller than 3/4-inch and for valve and fitting identification, use valve tag.
- C. For sizes from 3/4 to 1-1/4-inch outside diameter, 1/2-inch letters, 8-inch marker width.
- D. For sizes from 1-1/2 to 2-inch outside diameter, 3/4-inch letters, 8-inch marker width.
- E. For sizes from 2-1/2 to 6-inch outside diameter, 1-1/4-inch letters, 12-inch marker width.
- F. For sizes from 8 to 10-inch outside diameter, 2-1/2-inch letters, 24-inch marker width.
- G. For sizes 10-inche outside diameter and larger, 3-1/2-inch letters, 32-inch marker width.
- H. Identify pipe markers and color coded as follows with directional arrows.

HVAC SERVICE	PIPE MARKER *	BACKGROUND/TEXT COLOR
HEATING WATER	HEATING WATER SUPPLY	GREEN/WHITE
	HEATING WATER RETURN	GREEN/WHITE
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		

PART 3 – EXECUTION

3.01 VALVE IDENTIFICATION

- A. Valve Tags:
1. Attach to valve with a brass chain.
 2. Valve tag numbers continuous throughout the building for each system.
 3. Obtain a list for each system involved from the Owner.
- B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.02 PIPING MARKERS

- A. Unless recommendations of ANSI A13.1 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
1. Every 20-feet along continuous exposed lines.
 2. Every 10-feet along continuous concealed lines.
 3. Adjacent to each valve, flange, and stub-out for future.
 4. On pipe before and after wall, floor, and ceiling penetrations.
 5. On pipe into and out of concealed spaces.
 6. Adjacent to changes in pipe direction.
 7. On each riser.
 8. Adjacent to each leg of a T.
 9. Locate conspicuously where visible. Position pipe labels on pipe to achieve the best visibility.

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IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

10. Provide pipe identification (over insulation) for reclaimed water systems in accordance with current local codes and rulings.
 11. Apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above.
- B. Apply arrow labels indicating direction of flow.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Testing and Balancing of Air Systems
 - 2. Testing and Balancing of Hydronic Systems
 - 3. Testing and Balancing of Miscellaneous Mechanical Equipment

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 09 00, Instrumentation and Controls for HVAC

1.03 QUALITY ASSURANCE

- A. Acceptable Testing and Balancing Firms:
 - 1. A.I.R., Inc.
 - 2. Air Balance Specialty, Inc.
 - 3. Neudorfer Engineers, Inc.
 - 4. Northwest Engineering Services
 - 5. Pacific Coast Air Balance
 - 6. Accurate Balancing Agency, Inc.
 - 7. Precision Test and Balance, Inc.
- B. Other Firms: Submit substitution requests prior to bid date.
- C. Industrial Standards: Testing and Balancing shall conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
 - 1. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
 - 2. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
 - 3. ANSI:
 - a. S1.4 Specifications for sound level meters.
 - b. S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.
- D. Instrument Certification: Instruments used shall be accurately calibrated and certified within six months of balancing and maintained in good working order.
- E. Test Observation: If requested, the tests shall be conducted in the presence of the Architect or the Architect's representative.
- F. Pre-Balancing Conference:
 - 1. Prior to starting balancing, general techniques shall be reviewed with the Engineer. This conference must occur prior to measuring existing conditions.
 - 2. Measuring of existing conditions must occur prior to any demolition or new work.
 - 3. The conference will review existing conditions and systems to be affected by the project

1.04 SUBMITTALS

- A. Submit the following:
1. Balancing Log – Existing Systems: Submit preliminary report indicating existing conditions prior to making any modifications to existing systems.
 - a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
 - b. Provide drawings identifying location of all outlets.
 2. Equipment Data Sheets – Existing Systems: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
 3. Balancing Log:
 - a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
 - b. Provide drawings identifying location of all outlets.
 4. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
 5. Additional Data: Submit additional data as provided by Associated Air Balance Council (AABC) Standard forms.
 6. Number of Copies: Submit six copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
 7. Instrument Certification: When requested, submit certificate of calibration for equipment to be used.
- B. Record data on NEBB forms or forms approved by the Architect.

1.05 PROJECT CONDITIONS

- A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. Adjust central equipment as required and restore all unmodified branches and outlets to original condition. Obtain existing system drawings from Owner and become familiar with extent and nature of existing systems.
- B. Do not perform final testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and operating continuously as required.
- C. Conduct air testing and balancing with clean filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.06 WARRANTIES

- A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Balance to maximum measured flow. Deviation from specified values of ± 10 percent at terminal device and ± 5 percent at equipment, or mean sound level deviation of 15 decibels. Advise Engineer if deficiencies are generally noted to enable proper corrective actions.

3.02 AIR SYSTEMS

- A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.
- B. Preliminary:
 - 1. Identify and list size, type, and manufacture of all equipment to be tested including air outlets and inlets.
 - 2. Use manufacturer's ratings for equipment to make required calculations except where field test shows ratings to be impractical.
- C. Distribution:
 - 1. Evaluate all building and room pressure conditions to determine adequate supply and return air conditions. Balance the building to be slightly positive to outdoors.
 - 2. Evaluate all building and room pressure conditions to determine adequate performance of the system to maintain temperatures without draft.
 - 3. Perform multipoint pitot traverses to confirm instrumentation, shaft tightness, fan operation, etc. Pitot traverses shall be performed using a Dwyer Series 400 air velocity meter only with applicable duct probe.
 - 4. Mark balancing dampers.
- D. Fire Life Safety Systems:
 - 1. Balance, adjust, and test the stair and elevator pressurization components in order to pass the city test as described in Section 23 09 00, Instrumentation and Controls for HVAC. The balancer shall rebalance the system as necessary until it passes the city tests.

3.03 HYDRONIC SYSTEMS

- A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.
- B. Preliminary:
 - 1. List complete data of tested equipment and verify against Contract Documents.
 - 2. Open all line valves to full open position, close coil by-pass stop valves, and then set mixing control valve to full coil flow.
 - 3. For each pump:
 - a. Verify rotation.
 - b. Test and record pump shut-off head.
 - c. Test and record pump wide-open head.
 - 4. Verify proper system pressures.
 - 5. Verify air vents in high points of water are properly installed and operating freely.
- C. Distribution:
 - 1. Read and adjust water flow for design conditions.
 - 2. Set all memory stops and mark position of adjuster on balancing valves.

3.04 ELECTRIC HEATING EQUIPMENT

- A. Test and record voltage and amperage readings at each electric heating device while fully energized and at part load conditions (each step) to verify proper operation.
- B. Record data on appropriate forms.

3.05 AUTOMATIC CONTROL SYSTEM

- A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

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- B. Testing organization shall verify all controls for proper calibration and list controls requiring adjustment by control system installer.

3.06 COORDINATION

- A. Coordinate work with other trades to ensure rapid completion of the project.
- B. Deficiencies noted during the course of air balancing in the mechanical installation shall be promptly reported to the Architect to allow corrective action to proceed.
- C. Periodic review of progress shall be provided as requested.

END OF SECTION

SECTION 23 07 00
INSULATION FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Pipe Insulation
 - 2. Ductwork Blanket Insulation
 - 3. Duct Insulation, Internal
 - 4. Duct, Pipe and Terminal Unit Acoustical Wrap
 - 5. Duct Enclosure, Fire Rated
 - 6. Accessories Piping
 - 7. Accessories Ductwork

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 05 29, Hangers, Supports and Anchors for HVAC
- D. Section 23 31 01, HVAC Ducts and Casing – Low Pressure

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Prohibit insulating products from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
 - 2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723 or ASTM E84.
 - 3. Energy Codes: Local Building and Energy Codes govern where insulation performance requirements for thickness exceeds thickness specified.
- B. Protection:
 - 1. Protect against dirt, water, chemical, or mechanical damage before, during, and after installation.
 - 2. Repair or replace damaged insulation at no additional cost.
- C. Source Quality Control:
 - 1. Service: Use insulation specifically manufactured for service specified.
 - 2. Labeling: Insulation labeled or stamped with brand name and number.
 - 3. Insulation and accessories not to provide nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, not to react corrosively with equipment, piping, or ductwork, and asbestos free.

1.04 SUBMITTALS

- A. Submit the following.
 - 1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Pipe Insulation:
 - 1. Fiberglass:
 - a. Johns Manville Microlok HP
 - 2. Calcium Silicate:
 - a. Johns Manville Thermo-12 Gold
 - 3. Elastomeric:
 - a. ArmacellAP Armaflex
 - b. Rubatex
 - c. K-Flex
 - 4. Cellular Glass:
 - a. Pittsburgh Corning Foamglas
 - b. Pittwrap SS Jacket
- B. Ductwork Blanket Insulation:
 - 1. Fiberglass:
 - a. Johns Manville Microlite Type 100
 - 2. Elastomeric:
 - a. Armacell Armafle
- C. Duct Insulation, Internal:
 - 1. Round Ductwork:
 - a. CertainTeed
 - b. Johns Manville
 - 2. Rectangular Ductwork:
 - a. CertainTeed
 - b. Johns Manville
 - c. Knauf
 - d. Owens Corning

2.02 PIPE INSULATION

- A. Fiberglass: Split sectional or Snap-On type with 0.23 per-inch maximum thermal conductivity (K-factor) at 75 degrees F mean temperature, 850 degrees F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system.
- B. Calcium Silicate: Sectional with 14 pcf nominal density, 0.40 maximum K-factor at 300 degrees F mean temperature and 1200 degrees F maximum service rating.
- C. Elastomeric:
 - 1. Expanded closed cell, 0.27 per-inch maximum K-factor at 75 degrees F mean temperature, 220 degrees F maximum service rating with fitting covers and paintable surface.
 - 2. Color:
 - a. Concealed Locations: Black
 - b. Exposed Locations: White.

- D. Cellular Glass:
 - 1. Light weight rigid glass foam insulation, 0.34 per-inch maximum K factor at 75 degrees F mean temperature, 900 degree degrees F maximum service rating.
 - 2. Field applied jacketing, woven glass fabric, bituminous resin, poly-ethylene film.
- E. Mineral Wool: Sectional mineral wool, 8 psf density, 0.31 per-inch maximum K-factor at 75 degrees F temperature, 1200 degrees F maximum service rating.

2.03 DUCTWORK BLANKET INSULATION

- A. Fiberglass: 1.0 pcf nominal density, 0.25 per-inch maximum K-factor at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit.
 - 1. Exposed: FSK facing (foil scrim Kraft) or vinyl - white appearance.
 - 2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
 - 3. Concealed without Vapor Barrier: Facing not required.
- B. Semi-Rigid Fiberglass: 2.5 pcf nominal density, 0.24 per-inch maximum K-factor, at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit.
 - 1. Exposed: FSK facing (foil scrim Kraft) or vinyl-white appearance.
 - 2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
 - 3. Concealed without Vapor Barrier: Facing not required.
- C. Elastomeric: Expanded closed cell sheets, 0.27 per-inch maximum K-factor at 75 degrees F mean temperature and 220 degrees F minimum operating temperature limit.

2.04 DUCT INSULATION, INTERNAL

- A. Fiberglass Duct Liner.
 - 1. Thermal Conductance: k-0.23 in accordance with ASTM C518 and ASTM C177 at 75 degrees F mean temperature.
 - 2. Maximum Operating Temperature: 250 degrees F as determined by ASTM C 411.
 - 3. Maximum Air Velocity: 6,000 fpm as determined by ASTM C 1071.
 - 4. Fungi Resistance:
 - a. Does not breed or promote as determined by ASTM C1338.
 - b. No growth as determined by ASTM G21.
 - 5. Bacteria Resistance: No growth as determined by ASTM G22.
 - 6. Flame-spread index of 25 or less as determined by ASTM E 84 or UL 723.
 - 7. Smoke development index of 50 or less as determined by ASTM E 84 or UL 723.
 - 8. Acoustical Absorption Coefficients:
 - a. NRC value as tested in accordance with ASTM C423, type A mounting:
 - 1) 1-inch thickness: Minimum NRC 0.70
 - 2) 2-inch thickness: Minimum NRC 0.90

2.05 ACCESSORIES PIPING

- A. Adhesives:
 - 1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
 - 2. Fiberglass: Integral closure system.
 - 3. Calcium Silicate: Benjamin Foster 30-36.
 - 4. Elastomeric: Armacell 520 BLV.

- B. Cements:
 - 1. Insulating: Ryder.
 - 2. Heat Transfer: Chemax Tracit-300.
- C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.
- D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.
- E. Grooved Coupling Insulation: One piece PVC insulated fitting cover. Zeston, Ceel-Co.
- F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.
- G. Cloth Facing: Presized fiberglass cloth.
- H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F. Zeston Z-tape.
- I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

2.06 ACCESSORIES DUCTWORK

- A. Adhesives:
 - 1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
 - 2. Fiberglass: Benjamin Foster 85-62, Design Polymerics 2501/2502
 - 3. Elastomeric: Armacell 520 BLV
 - 4. Duct Insulation, Internal: Foster 85-62, Design Polymerics 2501/2502
- B. Weld Pins: Duro-Dyne with NC-1 nylon stop clips
- C. Cements:
 - 1. Insulating: Ryder.
 - 2. Heat Transfer: Chemax Tracit-300
- D. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.
- E. Mastic: Chicago Mastic:
 - 1. Vapor Barrier: 17-475
 - 2. Outdoor Mastic: 16-110 white
- F. Cloth Facing: Presized fiberglass cloth
- G. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F. Zeston Z-tape.
- H. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

PART 3 – EXECUTION

3.01 GENERAL

- A. Workmanship:
 - 1. Installation: Insulation installed in first class, neat professional manner.
 - 2. Applicators: Employ by firm that specializes in insulation work.
- B. Preparation: Surfaces of piping, ductwork, and equipment clean, free of oil or dirt, and dry before insulation is applied.
- C. Stamps: ASME stamps, UL labels, and similar stamps and labels not covered.

3.02 HVAC PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – HVAC Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Heating Water (to 200 degrees F)	1-1/4-inch and smaller	Fiberglass	1-1/2-inch	Note 1
Heating Water (to 200 degrees F)	1-1/2-inch and above	Fiberglass	2-inch	Note 1
Condensate or other cold water drains	All	Elastomeric	1/2-inch	
Note 1: Cover with metal pipe jacket where exposed to weather and over heat trace cable.				

B. The following piping is not insulated:

1. Refrigerant relief valve discharge.
2. Condenser water, inside building, except where used for water side economizer.
3. Steam safety valve discharge higher than 8-feet above floor.
4. Steam vents from condensate, higher than 8-feet above floor pumps, deaerators, etc.
5. Steam traps.

C. Include fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves, except valve bonnets, unions and flanges need not be insulated on the following systems:

1. High, medium, and low pressure steam, inside building, 2-inch and smaller.
2. Condensate, pumped condensate, feed water, inside building.
3. Hot water heating, and heat recovery, inside building.

D. Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4-feet of the coils and the pipe size is 1-inch or less.

E. Valves, humidifier bodies, and irregular fittings insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 ounces canvas and Foster 30-36 lagging adhesive.

F. Option on flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 ounces glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge SS lacing wire.

3.03 PIPING INSTALLATION

A. General:

1. Joints: Coat both sides of complete joining area with applicable adhesive.
 - a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
 - b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
 - c. Multiple Layered Insulation: Joints staggered.
2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.

3. Voids:
 - a. Fill voids, chipped corners and other openings with insulating cement or material compatible with insulating material.
 - b. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
4. Seal joints, seams, and fittings of metal watertight jackets at exterior locations.
- B. Fiberglass Insulation: Exterior insulation encased in metal jacket.
- C. Elastomeric Insulation:
 1. Slit full length and snap around pipe.
 2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
 3. Do not stretch insulation to cover joints or fittings.
 4. Seal joints in elastomeric insulation with adhesive.
 5. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
 6. Sealing joints with tape will not be allowed.
- D. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
 1. On Elastomeric Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
 2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.
- E. Unions, Mechanical Joints, Valves, etc.:
 1. General:
 - a. As specified for fittings.
 - b. Minimum thickness same as specified for piping.
 2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
 3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
 4. Flanged Valves: Insulation with square corners.
- F. Vapor Barrier Insulation:
 1. Refer to Section 23 05 29 Hangers, Supports, and Anchors for HVAC, for support requirements.
 2. Piping which requires vapor barrier protection has a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
 - a. Chilled water including radiant cooling water.
 - b. Brine water.
 - c. Refrigerant suction.
 - d. Other piping systems with a nominal operating temperature below 65 degrees F.
 3. Vapor Barrier Insulation.
 - a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.

- b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 23 05 29, Hangers, Supports, and Anchors for HVAC.

G. Non-Vapor Barrier Insulation:

1. Refer to Section 23 05 29, Hangers, Supports, and Anchors for HVAC for support requirements.
2. Insulation may be interrupted at supports. Butt insulation tight to support.
3. Continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
4. Void between saddle and pipe filled with insulation.

3.04 DUCT INSULATION APPLIED LOCATIONS

A. General:

1. Provide external insulation with continuous vapor barriers unless specifically noted otherwise.
2. Internally line ductwork completely to grille or diffuser or to indicated terminal points. Dimension shown are net inside of liner.
3. Internally lined ductwork need not be externally insulated.
4. In addition to locations described in specification, internally line medium, low, return and exhaust air ductwork where shown on drawings.
5. Internal lining is not allowed downstream of final filters in systems serving inpatient healthcare facilities.

B. Insulation Applied Location – HVAC Ductwork:

System	Location	Duct Type	Insulation Type	Thickness	Notes
Low Pressure Supply*	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	1-1/2-inch	
		Round	Internally Lined	1-1/2-inch	Note 3
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1-1/2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	3-inch	Note 3
	Under Slab Ductwork	All	Internally Lined	2-inch	
	Downstream of Air Terminal Units	All	Internally Lined	1-1/2-inch	Note 1 Note 3
	15-feet upstream and downstream of fans	All	Internally Lined	1-1/2-inch unless otherwise indicated	Note 3
Return Air* (not insulated except)	Concealed Outside Building Envelope	All	Externally insulated without vapor barrier	2-inch	

System	Location	Duct Type	Insulation Type	Thickness	Notes
	Exposed Outside Building Envelope	All	Internally Lined	2-inch	Note 3
	Under Slab Ductwork	All	Internally Lined	2-inch	Note 3
	15-feet upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	Note 3
Exhaust Air* (not insulated except)	15-feet upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	Note 3
	In Toilet Rooms, 10-feet downstream of exhaust grilles	All	Internally Lined	1-inch	Note 3
Supply and Return Plenums	All	All	Internally Lined	2-inch	Note 2
Transfer Air	All	All	Internally Lined	1-inch	Note 3
<p>* In addition to applied locations listed in this table, provide internally lined ductwork where indicated on drawings. Note 1: Except ductwork downstream of terminal units serving patient care areas in hospitals Note 2: Insulation not required on factory fabricated insulated housings and plenums (AHP). Note 3: Where round or oval ductwork is indicated, provide double walled round/oval ductwork as specified in Section 23 31 02, HVAC Ducts and Casing-Medium Pressure, or provide internally lined rectangular ductwork with equivalent free area may be substituted.</p>					

3.05 DUCTWORK INSTALLATION

- A. General:
 - 1. Install in accordance with manufacturer's instruction.
 - 2. Continuous vapor barrier. Coat with vapor barrier mastic and patch with facing or tape. Joints between insulation and access with vapor barrier mastic.
 - 3. Insulation at access panels to be removable or attached to panel with edges of panel and opening reinforced with metal beading.
- B. External Blanket Insulation:
 - 1. Insulation secured to ductwork with 20-gauge snap wires 24-inches on center and at all joints.
 - 2. Joints and seams lapped a minimum of 3-inches and sealed with jacket tape.
- C. Internal Duct Liner:
 - 1. Air stream coated surface.
 - 2. Weld pins spaced maximum of 15-inch on center in both directions and within 2-inches of corners and joints. Weld pins flush with liner surface.

3. Complete duct surface coated with adhesive and insulation pressed tightly thereto.
 4. Provide edges at terminal points with metal beading and heavily coated with adhesive.
 5. Heavily coat joints and corners with adhesive.
 6. Damaged areas replaced or heavily coated with adhesive.
- D. Plenums: Insulation on floors protected by wire mesh.
- E. Blank-Off Panels: Insulation, enclosed with sheet metal on all sides. Joints with vapor barrier mastic and taped.
- F. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep, and finish edges to maintain vapor barrier and to prevent damage to the insulation.

3.06 DUCT, PIPE AND TERMINAL UNIT ACOUSTICAL WRAP

- A. Installed in accordance with the manufacturer's instructions.
- B. Applied locations for piping and duct systems:
1. Variable and constant volume terminal units with maximum air volumes over 2000 cfm. Wrap installed such that control devices are easily accessible without circumventing the acoustical value.
 2. Where specified or indicated on drawings.

3.07 FIELD QUALITY CONTROL

- A. Field Test: Test and approve systems prior to installation of insulation.
- B. Existing Insulation:
1. Repair existing insulation damaged during construction.
 2. Make neat connections where new and existing insulation meet.
 3. Where existing piping, ductwork or equipment is removed, cover existing surfaces neatly to match existing.
 4. Where existing insulation is damaged or missing, notify the architect prior to performing to work.

END OF SECTION

SECTION 23 09 00

INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Materials and Equipment
 - 2. Control Devices
 - 3. DDC Field Panels
 - 4. Connection to Existing Network
 - 5. BACnet Compatibility
 - 6. Operator Interface System
 - 7. Application Programs
 - 8. Input/Output Functions
 - 9. Uninterruptable Power Supply
 - 10. Energy Management System

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 05 93, Testing, Adjusting and Balancing
- D. Section 23 21 13, Pipe and Pipe Fittings HVAC

1.03 QUALITY ASSURANCE

- A. Provide control work by single company with specialists in the type of work required, so that only one control manufacturer is responsible for control and automation work for project.
- B. Provide coordination with other contractors or subcontractors for work required by other trades for accomplishment of control work.
- C. Prior to substantial completion, controls contractor must demonstrate to Owner that system is operating per the Specifications and final adjustments have been made as approved.
- D. System, including components and appurtenances, configured and installed to yield a Mean Time Between Failure (MTBF) of at least 1,000 hours.

1.04 SUBMITTALS

- A. System Drawings: Prepare on AutoCAD format and include the following:
 - 1. Equipment installation, block diagrams, and wiring diagrams.
 - 2. DDC panel physical layout and schematics.
 - 3. Sensor and control wiring and installation drawings which identify each component and show interconnected or interlocked components.
 - 4. Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications.
 - 5. Details of connections to power sources, including grounding.
 - 6. Details of surge protection device installations.
 - 7. Instrumentation and control diagrams.

8. Complete a written description of control sequences.
9. List of connected data points, including DDC panels to which they are connected, and input device (sensor, etc.).
10. Valve and damper schedules indicating flows, pressure drops, CVs, and actuator type.
11. Graphics: System graphics for review prior to implementation of programming.
- B. Equipment Data: Submittals include complete data for materials, including field and system equipment.
- C. Software Data:
 1. Submittals consist of complete descriptions of system, command, and applications software as specified.
 2. Include description of control sequences which are software based using detailed logic flow diagrams.
 3. Diagrams indicate logic used to achieve control sequence of calculation specified, and show relationship between control sequence and application software packages specified.
- D. Testing Submittals:
 1. Provide test plan and test procedures for approval.
 2. Explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system.
 3. Test plan and test procedures demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.
- E. Operation and Maintenance Manuals:
 1. Provide three complete sets of manuals bound in loose-leaf binders within 30 days after completing acceptance tests.
 2. Identify each manual's contents on cover.
 3. Manuals include names, addresses, and telephone numbers of each subcontractor installing equipment and systems and of nearest service representatives for each item of equipment and each system.
 4. Place tab sheets at beginning of each chapter or section and at beginning of each appendix.
 5. Final copies delivered after completion of the acceptance tests include modifications made during installation, checkout, and acceptance.
 6. Operation and Maintenance Manuals to include hardware manual, software manual, operations manual, and maintenance manual.
 7. Hardware Manual: Furnish a hardware manual describing equipment provided, including:
 - a. General description and specifications.
 - b. Installation and checkout procedures.
 - c. Equipment electrical schematics and layout drawings.
 - d. System schematics and I-O wiring lists.
 - e. Alignment and calibration procedures.
 8. Software Manual:
 - a. Describe furnished software.

- b. Oriented to programmers and describe calling requirements, data exchange requirements, data file requirements and other information necessary to enable proper integration, loading, testing, and program execution.
 - c. Provide one software manual per Operator's Terminal.
- 9. Operator's Manual: Provide procedures and instructions for operation of the system, including:
 - a. DDC Panels and Peripherals
 - b. System start-up and shutdown procedures.
 - c. Use of system, command, and applications software.
 - d. Alarm Presentation
 - e. Recovery and Restart Procedures
 - f. Report Generation
 - g. System Schematic Graphics
 - h. Provide one Operator's Manual per Operator's Terminal
- 10. Maintenance Manual: Provide descriptions of maintenance for equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
- 11. Acceptance Test Forms: Maintenance manual includes copies of signed-off acceptance test forms.

1.05 ACCEPTANCE TESTING AND TRAINING

- A. Site Testing:
 - 1. General: Provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.
 - 2. Acceptance Test: Demonstrate compliance of completed control system with contract documents. Using approved test plan, physical and functional requirements of project demonstrated.
- B. Training:
 - 1. General:
 - a. Conduct training courses for designated personnel in operation and maintenance of system.
 - b. Oriented to specific system being installed under this contract.
 - c. Provide trainee with two additional copies provided for archival at project site.
 - d. Manuals include detailed description of the subject matter for each lesson.
 - e. Provide copies of audiovisuals to Owner.
 - f. Training day is defined as 8 hours of classroom instruction, including two, 15-minute breaks and excluding lunch time, Monday through Friday, during normal first shift in effect at training facility.
 - g. Notification of any planned training given to the Owner's representative at least 15 days prior to the training.

2. Operator's Training I:
 - a. Teach first course at supplier's facility for period of two consecutive training days.
 - b. Upon completion, each student, using appropriate documentation, perform elementary operations with guidance and describe general hardware architecture and functionality of system.
3. Operator's Training II:
 - a. Teach second course at project site for a period of one training day after completion of Contractor's field testing.
 - b. Include instruction on specific hardware configuration of installed system and specific instructions for operating the installed system.
 - c. Upon completion, each student able to start system, operate the system, recover the system after failure, and describe the specific hardware architecture and operation of system.
4. Operator's Training III:
 - a. Teach third course at project site for period of one training day no later than six months after completion of the acceptance test.
 - b. Structure course to address specific topics that students need to discuss and to answer questions concerning operation of system.
 - c. Upon completion, students fully proficient in system operation and have no unanswered questions regarding operation of installed system.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Alerton by Environmental Control
- B. Automated Logic by Climatech
- C. Unless otherwise noted, installed by manufacturer.
- D. Other Manufacturers: Submit substitution request.

2.02 SYSTEM DESCRIPTION

- A. General:
 1. Provide a complete control system, consisting primarily of electronic direct digital control devices.
 2. System consists of modular and distributed microprocessor based control and monitoring units connected together by communications trunks. Capable of global data sharing and communication between controllers.
 3. System architecture distributed and not rely on central processing unit (CPU) for sharing point data between controllers, or for control functions requiring data from other controllers.
 4. Multipurpose controller(s) consisting of CPU, system program, memory, power supply, and input/output drivers which communicated with terminal equipment controllers through a communications network.
 5. Provide operator's interface.
 6. Provide equipment, installation, wiring, and accessories as required but not necessarily specified to accomplish operations as described.
- B. Environmental Conditions:
 1. Rate DDC panels and other field equipment for continuous operation under ambient environmental conditions of 35 degrees F to 120 degrees F dry bulb and 10 percent to 95 percent relative humidity, noncondensing.

2. Instrumentation and control elements rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installation.
 3. Install control devices in an enclosure suitable for the installed environment.
- C. System Accuracy and Display:
1. DDC system to control space temperature with a range of 50 degrees F to 85 degrees F ± 1 degrees F for conditioned space (display to nearest 0.5 degrees F); 15 degrees F to 130 degrees F ± 1 degrees F for unconditioned space (display to nearest 0.5 degrees F). Return air humidity controlled to 20 percent RH to 35 percent RH ± 3 percent RH.
 2. DDC system to control duct temperature with a range of 40 degrees F to 140 degrees F ± 1 degrees F (display to nearest 0.5 degrees F).
 3. Water temperature with a range of 30 degrees F to 100 degrees F ± 1 degrees F (display to nearest 0.5 degrees F); the range of 100 degrees F to 300 degrees F ± 2 degrees F (display to nearest 0.5 degrees F); and water temperatures for the purpose of performing BTU calculations using differential temperatures to ± 0.5 degrees F using matched sensors (display to nearest 0.5 degrees F).
 4. Pressure with a range for the specific application ± 5 percent of range.

2.03 MATERIALS AND EQUIPMENT

- A. Controls and Power Wiring:
1. General: Electric equipment and wiring in accordance with Division 26, Electrical. Manual or automatic control and protective or signal devices required for operation specified, and control wiring required for controls and devices.
 2. Wiring:
 - a. Field and Subfield Panels:
 - 1) Voltage in panels not to exceed 120V. Where devices are wired to higher voltages, mount in suitable individual enclosures or group in separate control panel.
 - 2) Coordinate electrical power supply with Division 26.
 - b. Motor Control Centers: Responsibility for correct voltage of holding coils and starter wiring in pre-wired motor control centers interfacing with automatic controls is included hereunder.
 - c. Wiring for DDC systems communications buses two conductor minimum 18 gauge foil-shielded, stranded twisted pair cable rated at 300 VDC or more than 80 degrees C.
 3. Communications Links Surge Protection: Protect communications equipment against surges induced on any communications link. Cables and conductors which serve as communications links have surge protection circuits installed that meet the requirements of REA PE-60d.
 4. Communications Links Overvoltage Protection: Protect communications equipment against overvoltage on any communications link conductors. Cables and conductors which serve as communications links have overvoltage protection for voltages up to 480 VAC rms, 60 Hz installed. Instrument fuses or fusible resistors are acceptable for this application.
 5. Power Line Surge Protection:
 - a. Protect equipment connected to AC circuits from power line surges.
 - b. Do not use fuses for surge protection.

- B. Control Panels:
 - 1. Provide wall-mounted control panels as required to contain relays, terminal strips, power supplies and other equipment in building control system.
 - 2. UL listed, minimum NEMA 1, minimum 14 gauge steel with stiffeners, continuous hinge doors, locking handles, single point latch.

2.04 CONTROL DEVICES

- A. Temperature Instruments:
 - 1. Room Temperature Sensors: Platinum RTD type with accuracy of ± 0.4 degrees F at 70 degrees F; operating range 30 to 120 degrees F; linear to DDC system; single point sensing element in wall-mounted ventilated enclosure with insulating back plate if mounted on exterior wall.
 - a. Provide sensor with digital display.
 - b. Sensor to have user adjustment based on DDC programmed offset.
- B. Motorized Valves:
 - 1. Equip with equal percentage with tight shutoff.
 - 2. Two position valves line size (two position ball valves full port), modulating water valves sized at 5 psi drop or as shown on the Drawing.
 - 3. Screwed ends except 2-1/2-inch and larger valves with flanged ends.
 - 4. Select valves to modulate smoothly at system pressures and flows.
 - 5. Select valves with close-off ratings and spring ranges designed to operate at the maximum flows and maximum available pump heads scheduled without leakage.
 - 6. Bubble tight butterfly valves acceptable on 2-1/2-inch lines and above for two-position action only.
 - 7. Air handling unit heating and cooling coil valves sized for 5 psi drop, unless otherwise noted on drawings.
- C. Valve and Damper Operators:
 - 1. Electronic modulating actuators with low voltage DC or current positioning signal.
 - 2. Each actuator have current limiting circuitry incorporated in its design to prevent damage to the actuator.
 - 3. Modulating actuators be provided and accept 0-10 VDC or 2-10 VDC or 4-20 mA input signal.
 - 4. Actuators provide the minimum torque required for proper close-off against the system pressure for the required application.
 - 5. The spring return feature permits normally open or normally closed positions of the valve or damper.
 - 6. Direct shaft mount rotational actuators have external adjustable stops to limit the travel in either direction.
 - 7. Power actuators by 24 VAC.
 - 8. The actuator provides a clamp position feedback signal of 2-10 VDC. The feedback signal independent of the input signal, and may be used to parallel other actuators and provide true position indication.
- D. Current Transformer:
 - 1. Current status switch, adjustable setpoint 1-135A, ± 1 percent of range, capable of monitoring motor's status and detection of belt breaking or slipping.

2. Manufacturer:
 - a. Hawkeye 700
 - b. Or equal.

2.05 DDC FIELD PANELS

- A. Multipurpose Controllers:
 1. Stand-alone microprocessor based panels, enclosed in sturdy metal enclosure with two standard RS232 interface ports, network communications module, power supply, and battery back-up.
 2. Panels will be used to connect field sensors and control devices. Fully supervise each panel to detect failures. Construct panel so functions are implemented on replaceable circuit boards to permit field maintenance. Completely field programmable through portable terminal. Minimum 8-hour battery backup system.
 3. Each DDC panel linked with data trunk cable to other controllers and Operator's Terminals to distribute information. Field panels continuously exchange data through trunk cable without requiring output to input wiring between panels. The system arranged so that operations are maintained without the central computer being connected to the system.
 4. Upon failure of the DDC field panel, including transmission failure, the panel automatically forces the controls to remain in the last command status.
 5. Provide a real time clock with calendar maintaining seconds, minutes, hours, and days of the week, accurate to ± 10 seconds per day.
 6. Provide sufficient memory to perform specified and shown DDC field panel functions and operations, including spares. Each DDC panel to have 10 percent minimum spare memory board spacing.
 7. Each DDC field panel contain hardware to support power fail automatic restart.
 8. Provide locking type mounting cabinets with common keying.
 9. DDC field panel have built-in diagnostics to display to operator interface terminal any sensor transmitting signal out of its design range.
 10. Control logic done with software resident in each local DDC panel. Auxiliary relays may be used only when required for load contact rating.
 11. Panels UL listed.
- B. Terminal Equipment Controller:
 1. Terminal equipment controllers provided for each piece of equipment, as specified, and includes point inputs and outputs as necessary to perform specified control sequences.
 2. Each controller performing space temperature control provided with a matching room temperature sensor, which include terminal jack to monitor hardware and software associated with controller.
 3. Each room sensor includes setpoint adjustment dial, temperature indicator, and override switch. Override switch overrides night setback mode to normal (day) mode when activated by occupant. Adjustment dial and override switch may be locked out, overridden, or limited through software from central workstation or portable terminal.
 4. Each controller independent of other network communications. Controller receives real time data from central workstation or multipurpose controller.
 5. Controller utilizes proportional, integral, and derivative (PID) algorithms which is field adjustable.

6. Database and sequence of operation programs stored in non-volatile EEPROM and EPROM.
7. Controllers networked through communications link to the multipurpose controller.
8. Controllers powered from 24 VAC source. Provide dedicated power source. Coordinate with Division 26.
9. VAV box controllers include differential pressure transducer connected to manufacturer's standard velocity sensor, and includes provisions for both automatic and manual calibration of transducer to ensure against drift. Incorporate algorithm to allow for modulation of hot water heating valve, and supplementary hot water radiation valve. Fan-powered terminal units control series or parallel fan as appropriate. Provide fan status proof current switch.

2.06 CONNECTION TO EXISTING NETWORK

- A. General: Communication between peer-to-peer DDC control panels via TCP/IP over the existing Ethernet system.
- B. Provide software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing paging system.

2.07 BACNET COMPATIBILITY

- A. DDC System and components BACnet Data Communications Protocol compliant.
- B. System fully integrated and installed as a complete package of BACnet compliant controls and instrumentation.
- C. Capable of seamless BACnet integration with existing BACnet compliant devices as well as future BACnet compliant devices.
- D. No portals or third party devices required for integration with existing or future equipment.
- E. Devices utilized in the BACnet interface BACnet Testing Laboratories (BTL) listed and labeled.

2.08 OPERATOR INTERFACE SYSTEM

- A. Web-Based Access:
 1. Provide a web-based controls interface with at least three user login accounts and password each with the capability of different access privileges that performs data access, operator's commands, alarm notification, requests for reports, file generation, diagnostics, and modifications.
 2. Controls accessible in mechanical room by direct connection from a laptop to a data port.
 3. Provide a temporary computer located on-site in the mechanical room until the commissioning, testing, and balancing has been completed.
 4. Provide a temporary computer located on-site in the mechanical room, with software and capabilities necessary to support commissioning, testing, and balancing and other activities required for project completion.
- B. Graphics: Provide a complete graphics package with the following features:
 1. Provide separate schematic diagram depicting each system. Diagrams to show major components such as fans, dampers, heating and cooling coils, humidifiers, pumps, heat exchangers, chillers, boilers, towers, ductwork, piping, etc., arranged to convey to viewer system configuration and flow of each system.
 2. Provide plot plan, riser plan, and selected floor plans of buildings with the location of each mechanical room and major equipment location indicated.

3. Provide symbols superimposed on each schematic to indicate each control device including control valves, damper motors, temperature sensors, pressure sensors, etc. Provide real time dynamic displays of the temperature, humidity, pressure, flow rate, run status, alarm status, and etc., adjacent to each control symbol. Arrange CPU to update each displayed analog and digital value minimum of every 15 seconds.
 4. Provide indication of setpoints, with each setpoint value located adjacent to each sensed value.
 5. Provide means to allow the user to easily change or add graphics via computer assisted drawing function utilizing freehand mouse.
 6. Provide means to allow user to transfer repeated system schematics and symbols between graphics without redrawing them. Provide symbol library arranged to store commonly used symbols.
 7. Provide a "telescoping" or "zoom" program to allow use to move from plot plan to mechanical room plan to system graphic to control device display by simply clicking the mouse.
 8. Provide dual function windowing program to allow user to view a split screen and toggle between simultaneous operations.
- C. Trend Data Collection and Historical Data:
1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-intervals, time-synchronized intervals, change of value, or by event of which user-definable. Trend data collected and stored on hard disk for future diagnostics and reporting. Automatic trend collection may be scheduled of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
 2. Provide trend data reports to allow the user to view trended point data. Display data in both tabular and graphical format. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred online to Microsoft Excel.

2.09 APPLICATION PROGRAMS

- A. General: Provide user-programmable DDC system programs with library of base-level predefined functions with user specified parameters.
- B. Time of Day Scheduling:
 1. A minimum of six schedules provided for equipment operation.
 2. Seven unique days per schedule provided.
 3. Program individual time cycle capability for each piece of equipment.
- C. Control Priorities:
 1. Provide an effective order of control priorities such that each succeeding level of optimization does not interfere with a more critical function.
 2. Allow features as alarm actions and manual commands from the operator to override lower level functions (such as duty cycling or scheduling).
 3. Events, initiated outside the DDC system causing equipment shutdown automatically reset when events causing the shutdown is cleared, such as power failure or fire alarm. For alarms within the control system, mechanical equipment restart after the alarm condition is manually reset.

- D. Alarms: System provides following alarm processing capabilities:
1. Connected status or analog point may be designated as alarm input point.
 2. Start/stop points with status feedback as well as associated analog alarms have user-programmable inhibit time assigned to each point to prevent nuisance alarms from occurring during startup of HVAC equipment.
 3. Each alarmable point have change-of-state priority assignment assignable at 3 levels. One each for its level of criticality: low for such things as maintenance alarms, high for critical HVAC equipment alarms, and emergency for life safety alarms.
 4. User may designate which conditions of alarm causes alarms to be initiated for display. The user may also designate alarm message for alarm condition and for return to normal condition as desired. Each message may be up to 32 characters in length and up to 32 messages are available in each digital management system.
 5. This feature provides for orderly display of alarms based on criticality; alarm with highest level of priority displayed first.
 6. User may designate which conditions of alarm causes alarms to be initiated for display. User may also designate alarm message for alarm condition and for return to normal condition as desired. Each message may be up to 80 characters in length.
 7. Provide automatic phone dialing feature with the capability to report a general alarm recorded message.
- E. Security: System supports multi-level password access with the following minimum access levels:
1. Read-only level, without capability of changing any part of software.
 2. Adjustment level, allowing operator to adjust setpoints and schedules, force outputs on/off, but not to modify programming.
 3. Full programming access.
 4. System supports additional levels of programming access.
- F. Power Failure:
1. In the event of the loss of normal power, there is an orderly shutdown of controllers to prevent the loss of database or operating system software.
 2. Non-volatile memory incorporated for critical controller configuration data, and battery backup provided to support the real-time clock and volatile memory for a minimum of 72 hours.
 - a. During a loss of normal power, the control sequences go to normal system shutdown conditions.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller automatically resumes full operation without manual intervention through a normal soft-start sequence.
 - c. Should a controller memory be lost for any reason, the operator workstation automatically reloads the program without any intervention by the system operators.

2.10 INPUT/OUTPUT (I/O) FUNCTIONS

- A. Analog Inputs (AI):
1. AI function monitors each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation.
 2. Provide signal conditioning for each analog input.

3. Individually calibrate analog inputs for zero and span, in hardware or in software.
4. Minimum 12 bit A to D resolution.
- B. Analog Outputs (AO):
 1. The AO function accepts digital data, perform D-to-A conversion, and output a signal compatible with the operator.
 2. Individually calibrate analog outputs for zero and span.
 3. Provide short circuit protection.
 4. Minimum 8 bit D to A resolution.
- C. Digital Inputs (DI):
 1. DI function accepts ON/OFF, OPEN/CLOSE or other change of state (two-state data) indications.
 2. Provide isolation and protection against input voltage up to 180 Vac peak.
- D. Digital Outputs (DO):
 1. DO function provides contact closures for momentary and maintained operation of output devices.
 2. Closures have a minimum duration of 0.1 second.

2.11 UNINTERRUPTABLE POWER SUPPLY (UPS)

- A. General:
 1. Provide an uninterruptable power supply (UPS) for each DDC field panel.
 2. Fed by 120V AC emergency power circuits.
 3. Floor or wall mountable.
- B. UPS:
 1. Provide MGE Pulsar UPS or pre-bid approved equal.
 2. Products carry UL 1778 listing.
 3. Base sizing on peak current requirements of connected load plus 15 percent factor of safety.
 4. Provide manufacturer's standard three-year comprehensive warranty, including batteries.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Mounting Panels: Locate panels where shown on Drawings or near item of equipment to be controlled, but not on equipment itself.
- B. DDC Field Panels: Provide number of panels required to accommodate DI, DO, AI, and AO points and hardware and software to accomplish specified control sequenced. Locate panels in mechanical or electrical rooms. Submit proposed locations for approval prior to preparing control drawings.
- C. Pneumatic Signals: The use of pneumatic signals to start and stop motors is not allowed.
- D. Electrical:
 1. Provide control wiring for control devices and control panels.
 2. Run control wiring in conduit.
 3. Provide power wiring for control devices and control panels. Utilize designated circuits in electrical power panels. Refer to Electrical Drawings. If no circuits are designated for DDC Controls, submit detailed request for use of spare circuits at no additional cost.
 4. Install power wiring in conduit.

SECTION 23 09 00
INSTRUMENTATION AND CONTROLS FOR HVAC

5. Grounding: Instrumentation and communication grounding installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
6. Control voltage limited to maximum of 120V.
7. Where relay coil is connected to load side of motor starter to energize with motor operation, external control circuit properly fused with fuse block located in respective starter enclosure.
8. Where relays are used to control single-phase motors directly, provide contacts rated for not less than horsepower rating of largest motor switched by relay.
- E. Identification: Provide engraved nameplates identifying switches, lights and starters, and each control device where control function is not readily apparent.
- F. Room Thermostats and Room Sensors:
 1. Wall Thermostats and Room Sensors with User Adjustment: Mount at height of 42--inches above finished floor.
 2. Wall Thermostats and Room Sensors without User Adjustment: Mount at height of 60 inches above finished floor.
 3. Provide insulating back on thermostats mounted on exterior walls.
 4. Provide one thermostat for each zone of temperature control.
 5. Submit proposed locations for approval prior to preparing control drawings, where not shown or alternate location is proposed.

END OF SECTION

SECTION 23 21 13
PIPE AND PIPE FITTINGS HVAC

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Copper Pipe
 - 2. Unions
 - 3. Soldering and Brazing

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Piping material and installation to meet requirements of the local building codes and serving utility requirements.
- B. Grooved joint couplings and fittings products of a single manufacturer. Grooving tools by the same manufacturer as the grooved components.
 - 1. Castings used for coupling housings, fittings, valve bodies, etc., date stamped for quality assurance and traceability.
- C. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, re-clean, and reconnect without additional expense to the Owner.
- D. Correct damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.04 SUBMITTALS

- A. Submit the Following:
 - 1. List of piping materials indicating the service it is being used for. Do not submit piping product data.
 - 2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.
 - 3. Certificate of completion
 - 4. Treatment Reports
- B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.
- C. Other: Make certified welders' certificates available.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. As indicated.

2.02 COPPER PIPE

- A. Pipe: Hard drawn copper tubing, Class L, ASTM B 88.
- B. Fittings:
 - 1. Wrought copper, 150 psi.
 - 2. ANSI B16.22 for soldered joints.

3. ANSI B16.22 or B16.50 for brazed joints.
 - a. Manufactures:
 - 1) Chase
 - 2) Revere
 - 3) Mueller
 - 4) Other Manufacturers: Submit Substitution Request.
- C. Service:
 1. Chilled and heating water piping (Type L, hard drawn) up to and including 4-inches.
 2. Coil condensate drains and traps, cooling tower drains, and other miscellaneous drains.

2.03 UNIONS

- A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.
- B. Dielectric Fittings:
 1. Nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F1545.
 2. Suitable for the pressure and temperature to be encountered.

2.04 SOLDERING AND BRAZING

- A. Brazed Joints:
 1. Acceptable Manufacturers:
 - a. Westinghouse Phos-Copper
 - b. Dyna-Flow by J.W. Harris Co., Inc.
 - c. Other Manufacturers: Submit substitution request.
 2. Applied locations:
 - a. Below grade piping.
 - b. Above grade piping larger than 2-inches for the following services:
 - 1) Heating water.
 - 2) Chilled water.
 - 3) Condenser water.
 - 4) Heat recover water.
 - c. Refrigerant piping: Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
- B. Soldered Joints:
 1. Acceptable Manufacturers:
 - a. Wrought Copper Pipe Fittings:
 - 1) All-State 430 with Duzall Flux
 - 2) Engelhard Silvacbrite with Engelhard General Purpose Flux
 - 3) J.W. Harris Co.
 - b. Valves, Cast Fittings or Bronze Fittings:
 - 1) Harris Stay-Silv-15
 - 2) Handy & Harmon Sil-Fos.

2. Applied locations:
 - a. Above grade piping 2-inch and smaller for the following services:
 - 1) Heating water.
 - 2) Chilled water.
 - 3) Condenser water.
 - 4) Heat recovery water.
 - 5) Industrial cold water.
 - 6) Trap priming lines.
- C. Valves, Cast Fittings or Bronze Fittings:
 1. Acceptable Manufacturers:
 - a. Harris Stay-Silv-15
 - b. Handy & Harmon Sil-Fos.

PART 3 – EXECUTION

3.01 PIPING INSTALLATION

- A. Install unions in non-flanged piping connections to apparatus and adjacent to screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.
- B. Install piping as to vent and drain. Install according to manufacturer's recommendations.
- C. Support piping independently at apparatus so that its weight not carried by the equipment.
- D. Run piping clear of tube cleaning or removal/replacement access area on coils, heat exchangers, chillers, etc.
- E. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.

3.02 PIPING JOINTS

- A. Pipe and Fittings:
 1. Join using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes.
 2. Cleaning, cutting, reaming, grooving, etc. done with proper tools and equipment.
 3. Hacksaw pipe cutting prohibited.
 4. Peening of welds to stop leaks not permitted.
- B. Purge refrigerant piping with nitrogen continuously during the piping installation, and seal each branch outlet with Visqueen and tape or similar method to assure continued cleanliness of interior of piping until system is completed.
- C. Copper Piping:
 1. Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished.
 2. Joints uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.
- D. No couplings installed in floor or wall sleeves.

E. Welded Joints:

1. Preparation for Welding: Bevel piping on both ends before welding:

a. Use following weld spacing on butt welds:

Nominal Pipe Wall Thickness	Spacing	Bevel
1/4-inch or less	1/8-inch	37-1/2
Over 1/4-inch, less than 3/4-inch	3/16-inch	27-1/2

b. Before welding, remove corrosion products and foreign material from surfaces.

2. Welded Joints:

a. Arc weld joints using certified welders.

b. Port openings of fittings must match the inside diameter of the pipe to which they are welded.

c. Use full radius welding elbows for turns. Use welding tees for tees.

d. Reducing fittings must be used for size reduction.

e. Weldolets may be used for branches up through one-half the pipe size of the main to which they are attached.

f. Nipples are not allowed.

3. Welding Operation:

a. After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.

b. Weld reinforcement no less than 1/16-inch not more than 1/8-inch above normal surface of jointed sections. Reinforcement crowned at center and taper on each side to surfaces being joined. Exposed surface of weld present professional appearance and be free of depressions below surface of jointed members.

c. Do not weld when temperature of base metal is lower than 0 degrees F. Material to be welded during freezing temperatures made warm and dry before welding is started. Metal warm to the hand or approximately 60 degrees F.

F. Screwed Joints: Use Teflon tape or Teflon liquid dope applied to male threads only.

3.03 ADJUSTING AND CLEANING

A. General:

1. Clean interior of piping before installation.

2. Flush sediment out of piping systems after installation before connecting mechanical equipment to the piping.

3. When placing the water systems in service during construction, each system cleaned by circulating a solution with 1000 ppm of trisodium phosphate for 24 hours, then drained, flushed and placed in service.

4. Clean strainers prior to placing in service.

END OF SECTION

SECTION 23 31 01

HVAC DUCTS AND CASING-LOW PRESSURE

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Supports, Anchorage And Restraints
 - 2. Sheet Metal Ductwork
 - 3. Flexible Ducts
 - 4. Exposed or Visible Ductwork In Finished Spaces

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 07 00, Insulation for HVAC
- D. Section 23 33 00, Air Duct Accessories

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.
- B. Regulatory Requirements:
 - 1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
 - 2. Ductwork and components UL 181 listed, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Provide catalog data on each product specified hereunder.
 - 2. Schedule of duct construction standards.
 - 3. Provide shop drawings showing materials and construction details for single wall housing plenum.
 - 4. Provide shop drawings showing construction details, support, and seismic restraint of ductwork distribution systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Flexible Ducts:
 - 1. Thermaflex M-KE
 - 2. Gen Flex IMP-25S
 - 3. Other Manufacturers: Submit substitution request.

2.02 SUPPORTS, ANCHORAGE AND RESTRAINTS

- A. General:
 - 1. Provide design for supports, anchorages, and seismic restraints for equipment when not shown on the Drawings.

2. Supports, anchorage and restraints provided are required to resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
3. Follow provisions in Section 23 05 48, Vibration and Seismic Control for HVAC Piping and Equipment for seismic restraints.
4. Seismic restraints are not to introduce stresses in the ductwork caused by thermal expansion or contraction.
5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
- B. Suspended Ductwork: Provide seismic restraints in accordance with the latest edition of the SMACNA, Seismic Restraint Manual - Guidelines for Mechanical Systems for the seismic hazard level corresponding to the seismic zone in which the project is constructed.
- C. Engineered Support Systems: Provide designs and details for the following support systems with the seal of a professional engineer registered in the State having jurisdiction:
 1. Supports and seismic restraints for suspended ductwork and equipment.
 2. Support frames for ductwork and equipment which provide support from below.
 3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.03 SHEETMETAL DUCTWORK

- A. Fabricate from galvanized steel, unless noted otherwise.
- B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers, and supports in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, Latest Edition.
- C. Duct Classification: Ducts considered low pressure when design velocities are 2000 fpm or less and maximum static pressure is 2-inches wg positive or negative.
 1. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1/2-inch wg positive or negative.
 - a. Supply ductwork downstream from terminal units.
 - b. Supply, return or exhaust ductwork serving fans scheduled to operate at less than 1/2-inch wg
 - c. Supply, return, or exhaust branch ductwork which serves one or two inlets/outlets.
 2. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1-inch wg positive or negative.
 - a. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 1-inch wg On supply fans pressure drops for louvers, coils, clean filters, and sound traps may be deleted from scheduled fan static.
 - b. Supply, return, or exhaust ductwork serving multiple duct branches where contractor can demonstrate that pressures will not exceed 1-inch wg positive or negative.
 - c. Boiler direct vent combustion air intake ductwork.
 - d. Water heater direct vent combustion air intake ductwork.
 3. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 2-inches wg, positive or negative.
 - a. Supply, return, or exhaust ductwork serving fans scheduled to operate at pressures greater than 1-inch wg positive or negative.

- D. Longitudinal seams on rectangular duct, Pittsburgh or Button punch snap lock. Snap lock seams for round duct may be used only on ducts classified for 1/2-inch wg. Longitudinal seams for round ducts using lap and rivet, spot weld, or fillet weld may be used only on ducts classified for statics 1-inch wg or less.
- E. Joining and reinforcing systems manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA J, and Ductmate 25 is equivalent to SMACNA F.
- F. Use of adjustable round elbows not permitted.

2.04 FLEXIBLE DUCTS

- A. Flexible air duct with CPE or metal film liner permanently bonded to coated spring steel wire helix with 1-inch thick fiberglass insulation blanket covered with fiberglass reinforced metal film vapor barrier jacket.
- B. Duct rated for 6-inch wg positive and 1-inch wg negative.

2.05 EXPOSED OR VISIBLE DUCTWORK IN FINISHED SPACES

- A. Round:
 - 1. Material:
 - a. Round or flat oval, machine formed, spiral lock-seam galvanized sheet metal ductwork of thicknesses as listed for sheet metal duct.
 - b. Paintable surface.
 - 2. Fittings: Machine formed, shop fabricated, with welded seams, designed for easiest air flow, similar to United Sheet Metal numbers listed.
 - a. Mitered Elbow with Turning Vanes: Type EV-90-2.
 - b. Radius Elbows: Type E090-5. Similar for less than 90 degree elbows.
 - c. Tees: Type Con-T-1.
 - d. Reducing Fittings: May be used unless noted otherwise.
- B. Rectangular:
 - 1. Same as for sheet metal ductwork but paintable surface.
 - 2. Inside reinforcing.
 - 3. Use special care to prevent imperfections in the metal surface.

PART 3 – EXECUTION

3.01 APPLIED LOCATIONS

- A. Supply ductwork on downstream side of terminal box. Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.
- B. Supply Ductwork from Spin-In Fittings to Supply Outlet Collar Connection: Flexible duct, maximum 4-foot length.
- C. Return Air Trunk Ductwork from End Run to Unit Connection: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.
- D. Exhaust Ductwork: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.
- E. Ductwork between Transfer Grilles: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.
- F. Exposed or Visible Ductwork in Finished Spaces: Sheet metal as specified for application, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

3.02 INSTALLATION

- A. Ductwork:
1. Seal traverse joints with an approved mastic during joining procedure or tape after joining to provide airtight duct system.
 2. Low pressure ductwork hanger and support systems in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Wire supports are not allowed.
 3. Provide supplementary steel for support of ductwork in shafts and between building structural members.
 4. Fabricate changes in direction to permit easy air flow, using full 1.5D radius bends or fixed turning vanes in square elbows. Radius elbows less than 1.5D radius, splitter vanes.
 5. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.
 6. Where pipe, structural member, or other obstruction passes through a duct, provide streamlined sheet metal collar around member and increase duct size to maintain net free area. Fit collar and caulk to make air tight.
- B. Dampers: Install where shown and where necessary to complete final balancing of system. Install regulators as specified in Section 23 33 00, Air Duct Accessories for each specific project condition. Leave dampers locked wide open in preparation for balancing.
- C. Flexible Connectors: Make connections to fans and other rotating equipment with flexible connectors with 2-inch minimum clearance between casing and ductwork. Not required on internally spring isolated units.
- D. Spin-in Fittings:
1. Install at branch takeoffs to outlets using round or flex duct.
 2. Connect to flexible duct with draw band strap and minimum of two wraps of duct tape.
 3. Leave dampers locked wide open.
- E. Flexible Ducts:
1. Make connections at ends using draw band strap and a minimum of 2 wraps of duct tape.
 2. Suspend center spans from structure above using wire as required by code. Connect to manufacturer's eyelet on jacket or use 1-inch wide galvanized steel strap with single loop at top and smooth edges.
 3. Suspending duct by laying it on the ceiling is prohibited.
 4. Avoid crimping flex duct. Changes in direction made using 2D radius. Duct connections to grilles, registers, and diffusers using less than 2D radius bends are not acceptable. Where space is constricted, use sheet metal elbows or Thermaflex Flex Boots (or equal).
- F. Ductwork, Exposed or Visible in Finished Areas:
1. Use extreme care in handling and installing.
 2. Replace dented or damaged sections.
 3. Install ductwork straight and true, parallel to building lines.
 4. Make connections with pop rivets using couplings where applicable. Grind raw edges smooth and apply paintable sealant to cover imperfections.
 5. Remove excess sealant to provide a finished joint.

6. Provide floor, wall, and ceiling plates as specified in Section 23 05 00, Common Work Results for HVAC.
7. Finish, clean and prime ductwork, and hangers for painting.

3.03 FIELD QUALITY CONTROL

- A. Coordination with Balance Agency:
 1. Provide services of a sheet metal person familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating sheet metal dampers.
 2. Install missing dampers required to complete final balancing.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Medium Pressure Duct Accessories
 - 2. Low Pressure Duct Accessories
 - 3. Fire and Smoke Dampers

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 31 01, HVAC Ducts and Casing-Low Pressure
- D. Section 23 09 00, Instrumentation and Controls for HVAC

1.03 QUALITY ASSURANCE

- A. Work performed by qualified, experienced mechanics in accordance with the manual of Duct and Sheet Metal Construction of the National Association of Sheet Metal and Air Conditioning Contractors and these Specifications.
- B. Install entire ductwork system, including materials and installation, in accordance with NFPA 90A.
- C. Flexible connectors, flexible equipment connections, tapes, and sealants listed as UL 181, Class I air duct. Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.

1.04 SUBMITTALS

- A. Submit the following: Product data for Duct Accessories.
 - 1. Low Pressure Duct Accessories:
 - a. Access Doors
 - b. Water Eliminators
- B. Operation and Maintenance Data: Automatic dampers, fire dampers, smoke dampers. Combination smoke and fire dampers, air flow station.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Low Pressure Duct Accessories:
 - 1. Flexible Equipment Connector:
 - a. Duro Dyne Corporation
 - b. Ventfabrics
 - 2. Extrators:
 - a. Carnes
 - b. Anemostat
 - c. Barber-Coleman
 - d. Nailor-Hart
 - e. Or approved equal.

3. Access Doors:
 - a. Air Balance
 - b. Ruskin
 - c. Metco
 - d. Duro Dyne Corporation
 - e. Cesco
 - f. Nailor-Hart
 - g. Or approved equal.

2.02 LOW PRESSURE DUCT ACCESSORIES

- A. Damper Regulators:
 1. Acceptable Manufacturers:
 - a. Ventlok
 - b. Young
 - c. Duro Dyne Corporation
 - d. Or approved equal.
 2. Dial Regulator – Concealed or exposed duct in unfinished spaces:
 - a. Blade lengths 18-inch and less: 3/8-inch shaft
 - b. Blade lengths 19-inches and above: 1/2-inch shafts
 - c. Ventlok 635, or 638 for insulated duct
 3. Dial Regulator – Exposed duct in finished space:
 - a. 3/8-inch shaft
 - b. Ventlok 640
 4. Dial Regulator – Concealed or non-accessible duct:
 - a. Blade lengths 18-inch and less: 3/8-inch shaft
 - b. Blade lengths 19-inches and above: 1/2-inch shafts
 - c. Ventlok 666 regulator with 680 mitered gear assembly where right angled turn is necessary.
 5. End Bearings:
 - a. Ducts rated to 1-inch WG, open end, Ventlok 607.
 - b. Ducts rated above 1-inch WG, closed end, Ventlok 609.
 - c. Exposed ductwork, finished spaces, Ventlock 609.
 - d. Spring end bearings not allowed.
- B. Volume Damper Fabrication:
 1. Single blade dampers reinforced or crimped for rigidity, with pivot rod extending through duct. Dampers over 12-inches high use multiple opposed blade damper. Single blade damper no larger than 12-inches by 48-inches. Multiple blade damper factory fabricated, Ruskin MD-35 or equal.
 2. Minimum gauge and duct construction in accordance with SMACNA, HVAC Duct Construction Standards, latest edition.
 3. Splitter and butterfly dampers fabricated of 18 gauge galvanized steel.
 4. Dampers of length suitable to close branch ducts without damper flutter.
 5. Damper blade must be aligned with handle and index pointer.

- C. Flexible Equipment Connector:
 - 1. Description: Woven fiberglass fabric with neoprene coating, air-tight, water-tight, fire retardant.
 - 2. Minimum Density: 30 oz. per sq. yd.
 - 3. Temperature Range: -20 degrees F to 200 degrees F
 - 4. Pressure Range: -10-inch wg to +10-inch wg
- D. Extractors (EX): Gang operated blades, steel construction, blades at 1-inch centers, slide operator set 15 degrees into main trunk duct, Titus AG-45 with No. 1 operator.
- E. Spin-in Fittings:
 - 1. Sheet Metal Duct:
 - a. Straight pattern sheet metal spin-in fitting with scoops designed for connection to sheet metal ductwork, volume damper, and locking quadrant.
 - b. Construction with spot welds or rivets.
 - c. Button-punch fabrication prohibited.
 - 2. Fiberglass Duct:
 - a. Straight pattern sheet metal spin-in fitting with scoops designed for connection to fiberglass ductwork volume damper, and locking quadrant.
 - b. Spot weld or rivet construction.
 - c. Button-punch fabrication prohibited.
- F. Duct Sealer:
 - 1. Based On:
 - a. McGill Airseal Zero
 - b. Design Polymerics DP 1090
 - 2. Description:
 - a. Suitable for indoor/outdoor use, including application in moist conditions, rated to 10-inch wg.
 - b. Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 420 g/L less water.
 - c. SCAQMD Rule 1168 compliant.
- G. Duct Tape for Sheet Metal:
 - 1. ARNO C520 duct tape similar United
 - 2. Duro Dyne Corporation
 - 3. Nashua
- H. Tape and Adhesive/Activator System for Sheet Metal: Hardcast, Polymer Adhesives.
- I. Turning Vane Assemblies:
 - 1. Sheet Metal Vanes: Multiple radius hollow vane air foil type 2-inch (small vane) or 4-1/2-inch (large vane) inside radius, galvanized steel construction.
 - 2. Runners: Push-on type.
 - 3. Acoustical Vanes: Multiple radius air foil type, perforated steel construction with fiberglass fill. AirSan Acoustiturn or as approved.

J. Access Doors:

1. Doors complete with steel frame, steel door with backing plate, cam latches (two on units 14-inch by 14-inch and larger), hinge, and gasketing. Insulate doors on insulated or lined ducts.

2. Grease Duct Access Door: Construct of metal thickness equal to metal duct, doors air, and grease tight with hinge and hand operable latches. Ductmate.

3. Size:

Duct Width or Duct Diameter	Net Access Door Opening
Up to 8-inch	6-inch by 6-inch
9-inch to 12-inch	8-inch by 8-inch
13-inch to 20-inch	12-inch by 12-inch
21-inch to 30-inch	16-inch by 14-inch
31-inch to 42-inch	18-inch by 14-inch
Over 42-inch	Two 16-inch by 14-inch

- K. Drip Pans: Provide Type 304 stainless steel drip pans for cooling coils and exhaust heat recovery coils on built-up units as indicated.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install devices as shown on the Contract Drawings and per manufacturer's recommendations.
- B. Low Pressure Duct Accessory installation specified under Section 23 31 01, HVAC Ducts and Casing-Low Pressure.
- C. Access Doors: Install where indicated and at duct mounted coils, humidifiers, automatic control dampers, smoke dampers, fire dampers, air flow stations, to provide access for cleaning and maintenance.
- D. Drip Pans:
 1. Install under each cooling coil and exhaust heat recovery coil as indicated.
 2. Provide drain connection from each drip pan and pipe to nearest floor drain through trap.
 3. Drip pans over 6-feet in length require drain connections from both ends.
 4. Pitch drip pans in direction of air flow and to drain.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Diffusers and Grilles

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)
- C. Section 23 33 00, Duct Accessories

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings: Showing dimensions and details of construction.
 - 2. Product Data

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Where only Titus figure numbers are listed, equivalent products by the following manufacturers by using only one:
 - 1. Carnes
 - 2. Price
 - 3. Krueger
 - 4. Tuttle & Bailey
 - 5. Anemostat
 - 6. Nailor
 - 7. Other Manufacturers: Submit substitution request.

2.02 DIFFUSERS AND GRILLES

- A. Ceiling Supply Diffuser (C-1):
 - 1. Perforated face modular diffuser with adjustable modular core, steel panel, square or rectangular neck size as indicated, discharge pattern as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan).
 - 2. White baked enamel finish, Titus PMC.
- B. Ceiling Return/Exhaust Grille (C-2): Perforated face modular ceiling grille, steel panel, with duct adapters for round or rectangular as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), white baked enamel finish, Titus PAR.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install diffusers tight to their respective mounting surfaces.
- B. Installed plumb and true with room dimensions and accurately centered on projections as shown on the Architectural reflected ceiling plans.
- C. Install extractors behind duct mounted sidewall supply grilles, and where shown. Turning vanes allowable if condition is the last outlet on a branch.

- D. Set pattern control for directions of throw as shown on Drawings prior to air balancer arriving on Project.
- E. Paint ductwork behind outlets flat black.

3.02 PERFORMANCE

- A. Unit sizing is based on air being introduced at 20 degrees F temperature differential and being diffused at the 5-foot level to a velocity not greater than 50 FPM and a temperature differential not greater than 1.5 degrees F. Units are also selected so as not to exceed the NC-30 curve.

END OF SECTION

SECTION 23 82 00

CONVECTION HEATING AND COOLING UNITS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Cabinet Unit Heaters

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Catalog data showing dimensions and performance.
 - 2. Operation and Maintenance Data: Fan coil units, cabinet unit heaters, convectors, finned tube radiation, unit heaters, radiant panels, radiant sails, radiant concealed sails.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Cabinet Unit Heaters:
 - 1. Trane
 - 2. Carrier
 - 3. McQuay
 - 4. Ted Reed
 - 5. Air Therm
 - 6. Dunham Bush
 - 7. Other Manufacturers: Submit substitution request.

2.02 CABINET UNIT HEATERS

- A. Description:
 - 1. Provide cabinet unit heaters complete with heating elements, enclosures, fans, motors, and air filters.
 - 2. Capacity as indicated.
- B. Cabinet:
 - 1. 16 gauge front panels with 18 gauge end and top panels, insulated with 1-inch fiberglass, horizontal with integral stamped inlet and outlet grilles, tamper proof access doors, removable front panel.
 - 2. Recessed.
 - 3. Baked enamel finish color as selected by Architect.
 - 4. Recessed or semi-recessed units have four side overlap.
- C. Fans and Motor: Steel construction designed for minimum noise levels, direct drive type, multispeed permanent split capacitor motor or belt drive unit, fan controls.
- D. Filters: Throwaway type, 1-inch thick fiberglass.

- E. Water Coils:
 - 1. 3/4-inch OD seamless copper tubes, aluminum fins, and end supports.
 - 2. Provide shutoff valves on water lines, and unions for a complete system.
 - 3. Coil and Heater Construction: 250 psi working pressure.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Cabinet Unit Heaters:
 - 1. Install per manufacturer's instructions.
 - 2. Provide valves and specialties as detailed on Drawings.
 - 3. Refer to Drawings and Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment, for vibration isolation and seismic bracing requirements.
- B. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.

END OF SECTION