

SECTION 232500

STEAM AND STEAM CONDENSATE SPECIALTIES

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Steam traps.
- B. Strainers.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME B 31.9 and ANSI/ASME B31.1.

1.4 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230100.
- B. Submit shop drawings and product data for manufactured products and assemblies required for this project.
- C. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
- D. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 230100.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - STEAM TRAPS

- A. Sarco
- B. Armstrong
- C. Warren Webster

2.2 FLOAT AND THERMOSTATIC TRAPS

- A. ASTM A126, cast iron body and bolted cover for 125 psig WSP; provide access to internal parts without disturbing piping; with bottom drain plug, stainless steel or bronze bellows type air vent, stainless steel or copper float, stainless steel lever and valve assembly.

PART 3 – EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Install specialties as indicated on the drawings and as required in accordance with manufacturer's instructions.
- B. Install float and thermostatic traps to drain condensate from low pressure steam piping.
- C. Size steam trap to handle minimum of three times maximum condensate load of apparatus served.
- D. Traps used on steam mains and branches shall be minimum 3/4-inch size.
- E. Provide minimum 10-inch long dirt pocket of same pipe sizes as apparatus return connection between apparatus and steam trap.
- F. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

END OF SECTION

SECTION 238350

TERMINAL HEAT TRANSFER UNITS

PART 1 – GENERAL

1.1 WORK INCLUDES

- A. Fin tube radiation.
- B. Cabinet unit heaters.
- C. IFB duct coil.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230100.
- B. Submit shop drawings indicating cross section of cabinets, grille, bracing and reinforcing, and typical elevation.
- C. Submit product data indicating typical catalog of information including arrangements.
- D. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified heat required to actual heat output provided.
- E. Submit manufacturer's installation instructions.
- F. Submit color charts of standard finishes to Architect. Architect will select finish color.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 230100.
- B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.5 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70 code for internal wiring of factory wired equipment.
- B. NFPA 54 - National Fuel Gas Code.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - FIN TUBE RADIATION, CABINET UNIT HEATERS

- A. Vulcan
- B. Sterling
- C. Trane

2.2 FINTUBE RADIATION

- A. Heating Elements: As scheduled on drawings.
- B. Enclosure: As scheduled on the Drawings and complete with all accessories, including but not limited to corner pieces, end caps, and joint strips.
- C. Access Doors: For otherwise inaccessible valves, provide factory made permanently hinged access doors, 6 × 7 inch minimum size, integral with cabinet.
- D. Finish: Factory applied baked enamel finish of color as selected by the Architect.
- E. Element Brackets: Minimum 16-gauge galvanized steel to support from panel and noise-free element cradle.
- F. Capacity and Options: As scheduled on drawings.

2.3 CABINET UNIT HEATERS

- A. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 220 deg. F.
- B. Cabinets: Cabinets shall be formed from 14-gauge cold-rolled steel and shall be suitably braced and reinforced where necessary to provide stiffness, and accurately fitted to prevent air leakage. Adequate work area for installation of control valves or electrical equipment shall be provided on both sides of the cabinet. The motor/fan support shall be provided with a mid-length support gusset to ensure quiet operation. All cabinets shall be supplied with adjustable rear mounting brackets which shall provide adjustment to correct alignment of the unit at installation to non-square or out-of-true walls, joists, studs or surfaces. All cabinets shall be supplied with a continuous hinged front panel. The continuous hinge shall provide full swing through 90 degrees. A safety chain shall be provided as standard to prevent the face panel from swinging full open accidentally. This chain must be easily detached to allow full access for servicing.
- C. Finish: Factory-applied baked enamel finish of color as selected by the Architect.

- D. Filters: All filters supplied for cabinet unit heaters shall be 1-inch thick glass fiber throw-away type.
- E. Fans: Fan wheels shall be centrifugal, forward curved, double-width of electro-galvaneal steel. Fan housings shall be of formed galvanized sheet metal.
- F. Motors: All motors shall have integral thermal overload protection. All electric motors shall comply with Section 231700.
- G. Mounting: Units shall be of the mounting configurations as scheduled on the drawings.
- H. Capacity and Options: As scheduled on the drawings.

2.4 IFB DUCT COIL

A. General

- 1. Furnish IFB coil with performance as shown in the schedule. The unit inlet and discharge flanges shall be pre-punched and designed for easy adaptation to external duct work or optional accessories. The unit shall include all components and accessories as shown on drawings.
- 2. Coil shall have horizontal tubes.
- 3. All coils will be built with orientation and control locations as required per field conditions.
- 4. The coil shall be manufactured by the L.J. Wing Company.

B. Certification

- 1. Each coil shall be certified by ARI for compliance with ARI Standard 410 and bear the seal indicating manufacturer's compliance. Each coil shall carry ETL label for compliance with UL Standard 1995 and bear the seal indicating manufacturer's compliance. All electrical components shall be UL/CSA approved devices.

C. Heating Coil Construction and Material

- 1. Coil shall consist of a built-in series of finned heating elements.
- 2. By-passes with mechanically interlocked dampers shall be designed into the casing of each unit.
- 3. Coil shall be capable of maintaining a constant discharge air temperature within +/-5° F regardless of variations in entering air temperature.
- 4. Finned heating elements shall be fabricated of seamless 5/8 inch O.D. hairpin type copper tubes with 0.035 inch wall thickness.
- 5. Each element shall be individually secured to the supply and return headers by a brazed joint. Each element shall be individually removable for ease in maintenance and repair.
- 6. Fins shall be rectangular embossed aluminum with a thickness of 0.010 inch.
- 7. Headers shall be constructed of Schedule 40 steel pipe with a minimum wall thickness of 0.216". Each tube shall be free to expand and contract individually. Channel-shaped tube retainers shall maintain distances between tubes and shall be free floating to allow for tube expansion.

D. Dampers and Casing Construction

1. Dampers shall be arranged so as to completely enclose and isolate the heating elements of the coil when no temperature rise is required.
2. Intake dampers shall be constructed of heavy gauge galvanized steel die-formed to an aerodynamic shape designed for minimum airflow resistance. Outlet dampers shall be constructed of heavy gauge galvanized steel.
3. Damper position shall be controlled by direct coupled actuator. Individual face and by-pass damper blades shall be interconnected through precision punched 1/4" thick steel bar with brass pins. Maladjustment of individual dampers will not be possible.
4. Casing shall be constructed of heavy gauge galvanized steel.

E. Operation

1. Volume of air passing through the coil shall not vary more than +/-5% regardless of the position of the internal dampers.
2. The temperature at any point in a parallel plane to the face of the coil three feet downstream from the leaving air side will not vary more than +/-5° F from the average discharge air stream temperature.

F. Options and Accessories

1. Dampers shall be actuated by a direct-coupled, factory furnished, 24 volt Belimo electronic proportional damper actuator and discharge airstream thermostat to maintain constant leaving air temperature. Actuator shall be designed to receive a 2 vdc control signal. In the event of a control failure, damper actuator shall remain at the last controlling position.
2. Manufacturer shall provide manual reset electric freeze-stat with averaging capillary bulb to shut down air handler if temperature approaches freezing condition.
3. Manufacturer shall provide transformer to stepdown 115 Volt line voltage to 24 VAC control voltage.
4. Damper and casing surfaces shall be finished with air-dried, alkyd enamel paint.
5. Manufacturer shall provide controls to accept 2-10 vdc control signal.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work and opening dimensions are as indicated on shop drawings.
- B. Verify that required utilities are available, in proper location, and ready for use.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Locate fin tube radiation as indicated on the drawings and run cover continuously wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install end caps where units butt against walls.

- C. Installation of access doors in fin tube radiation must allow for full operation and maintenance of all recessed valves.
- D. Install cabinet unit heaters as indicated. Coordinate to assure correct recess size for recessed units.
- E. Protect units with protective covers during balance of construction.

3.3 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- C. After construction is completed, install new throw-away filters in all cabinet unit heaters.

END OF SECTION

SECTION 238600

IN-LINE FANS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Inline centrifugal fans.
- B. Ceiling cabinet fans.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230100.
- B. Provide product data on centrifugal fans and accessories as required for the work.
- C. Provide fan curves with specified operating point clearly plotted.
- D. Submit sound power levels for both fan inlet and outlet at rated capacity.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 230100.
- B. Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Greenheck
- B. Loren Cook
- C. Penn

D. Twin City

2.2 IN-LINE SQUARE CENTRIFUGAL FANS

- A. Square centrifugal in-line blowers shall be of the belt-driven type, as indicated on the Drawings. The blower housing shall be of the square design and constructed of heavy-gauge steel. All steel components shall be painted with enamel primer and a coat of gray enamel.
- B. Access doors shall be provided and shall be located on any side with the exception of the motor side, allowing wheel, bearings, shaft, and drive components to be serviced or removed without disturbing the ductwork connections.
- C. Square centrifugal in-line blowers shall have all aluminum centrifugal blower type wheels, featuring non-overloading backward inclined blades and a tapered inlet shroud. Wheels shall be statically and dynamically balanced.
- D. The motor and drives shall be isolated from the airstream.
- E. Motors shall be heavy-duty, permanently lubricated, sealed ball bearing type. Motors shall comply with Section 231700.
- F. Bearings shall be permanently sealed pillow block type. Bearings shall be selected for a minimum of 200,000 hours life at maximum cataloged operating speed.
- G. Fan shafts shall be ground the polished steel.
- H. For belt-driven fans, motor drives shall be variable pitch through 5 horsepower. Oil-resistant non-static belts shall be provided. Drives shall be sized for 165% of motor horsepower.
- I. Centrifugal in-line blowers shall be licensed to bear the AMCA seal for both air and sound.
- J. Units shall be supplied with options as scheduled on the drawings.

2.3 CEILING CABINET FANS

- A. Ceiling ventilators shall be direct-drive, forward-curved, centrifugal blower type. Fan wheels shall be constructed of galvanized steel and shall be dynamically balanced. Housings shall be constructed of galvanized steel and acoustically insulated for quiet operation. Integral aluminum backdraft dampers shall be standard.
- B. Blower and motor assemblies shall be easily removable from housings without disturbing the ductwork.
- C. Motors shall be permanently lubricated with built-in thermal overload protection and shall be factory tested prior to shipment. Motors shall comply with Section 231700.
- D. Units shall be supplied with an internal wiring box, disconnect receptacle, and options as scheduled on the drawings.
- E. Discharge positions shall be adjustable by moving interchangeable panels supplied with removable fasteners.

- F. Ceiling ventilators shall be furnished standard with a grille.
- G. Ceiling ventilators shall be certified and licensed to bear the AMCA seal for air and sound performance.

2.4 SPARE PARTS

- A. Belts: Provide one new set of belts for each fan furnished under this Contract.
- B. Mark each assembly with associated fan number.
- C. Hang the spare belts on a Contractor-furnished device where indicated by Owner.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- B. Install all fans in accordance with manufacturer's instructions.
- C. Install all in-line fans with vibration isolators and flexible electrical leads.
- D. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

END OF SECTION

SECTION 239000

DUCTWORK

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. HVAC ductwork
- B. Duct cleaning

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 REFERENCES

- A. Material, construction, and installation shall meet requirements of most recent editions of the following standards and references, except where more stringent requirements are specified or indicated on the Drawings.
 - 1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
 - 2. SMACNA - HVAC Duct Construction Standards.
 - 3. SMACNA - HVAC Duct Leakage Test Manual.

1.4 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230100.
- B. Indicate duct fittings, types, and particulars such as gauges, sizes, welds, and configuration prior to start of work.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.

- B. Steel Ducts: Fabricate with ASTM A653 Coating Designation "G60" zinc-coated (galvanized) steel sheet, of lock-forming quality. Steel sheet zinc coating shall be minimum of 0.60 oz. per sq.ft. total both sides, per Triple-Spot Test. Steel sheet shall be in accordance with ASTM A568 and/or ASTM A924. Testing shall be per ASTM A90.
- C. Aluminum Ducts: ANSI/ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- D. Flexible Ducts: Triple interlocking spiral of galvanized steel or aluminum construction; rated to 2 inches WG positive and 1.5 inches WG negative for low pressure ducts.
- E. Insulated Flexible Ducts:
 - 1. Flexible duct as indicated above wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 deg. F (0.034 KSI at 24 deg. C). Buckley Model BDA, acoustic flexible duct or equivalent.
- F. Fasteners: Rivets, bolts, or sheet metal screws (except laundry exhaust).
- G. Laundry Duct Fasteners: Fasteners shall not obstruct the exhaust flow or penetrate the ductwork. Install per dryer manufacturer installation instructions.
- H. Sealant:
 - 1. United McGill - United Duct Sealer (Water Base) or acceptable substitute.
 - a. Water-based duct sealant contains no solvents or asbestos and has no harmful fumes. It is nonflammable (wet or dry) and fire retardant. The antimicrobial and antibacterial agents contained in this sealant remain effective after it has cured.
 - b. Color: Gray.
 - c. Composition: Vinyl copolymer.
 - d. Solids Content: 69%.
 - e. Viscosity: 65,000 cps.
 - f. Weight per Gallon: 11.3 pounds.
 - g. UL Classified: Flame spread smoke developed at 0.020 inches thick.
 - h. Application temperature: +40 deg. F to +110 deg. F.
 - i. Operational Temperature: -25 deg. F to +200 deg. F.
 - j. Performance: Successfully tested to meet SMACNA leakage requirements; tests conducted from -40 inches wg to +40 inches wg.
 - k. Durability: Will exceed 500 hours under accelerated-aging (oxygen bomb) test conditions without degradation (ASTM D572); tested for 500 hours in QUV accelerated-exterior-aging apparatus with no degradation (ASTM C732).
 - l. Curing Time: 48 hours minimum.
 - m. Recommended Storage Temperature: +75 deg. F.
- I. Hanger Rods: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 HVAC DUCTWORK

- A. Fabricate, install, and support in accordance with SMACNA HVAC Duct Construction Standards and other referenced standards, except if more stringent requirements are specified or indicated on the Drawings. For each ductwork system provide duct material, gauges, and reinforcing, for external static pressures indicated on the drawing schedules. All ductwork on the project shall have a minimum basis of compliance of 2" W.G. pressure class.
- B. Ductwork shall be sealed in accordance with Seal Class A as defined in the SMACNA HVAC Duct Construction Standards.
- C. Size round ducts installed in place of rectangular ducts in accordance with SMACNA table of equivalent rectangular and round ducts. No variation of duct configuration or sizes is permitted except by written permission from the Engineer.
- D. Fittings:
 - 1. Construct all elbows, offsets, "tees," bends, turns, etc., with full radius inside (throat) and full radius outside (heel) duct wall. Inside and outside radii shall correspond to a fitting centerline radius of 1-1/2 times the width of the duct.
 - 2. In instances where a fitting centerline radius of 1-1/2 times the width of the duct cannot be installed, a fitting centerline radius equal to the width of the duct (1 times duct width), may be permitted. Fittings with a centerline radius less than the width of the duct (<1 times duct width) shall not be permitted.
 - 3. Radius fittings with a centerline radius less than 1-1/2 times the width of the duct shall be provided with full length splitter vanes, spaced per SMACNA design standards. Splitter vanes shall be fully welded in place. The Engineer's approval of the splitter vane design is required prior to fabrication.
 - 4. In instances where short radius fittings cannot be installed, rectangular mitered fittings may be permitted, provided single thickness turning vanes are installed. Turning vanes shall be continuously welded into supporting tracks. Turning vane supporting tracks shall be secured in fittings with sheet-metal screws or rivets for ducts with pressure classifications less than 2" W.G. For ducts with pressure classifications of 2" W.G. or greater, turning vane supporting tracks shall be welded into the fittings. Turning vanes shall be installed such that the leading and trailing edges of the vanes are plumb and parallel to the airstream for all fittings.
 - 5. Fittings with radius outside (heel) and square inside (throat) duct wall shall not be accepted. Mitered fittings without turning vanes shall not be accepted.
- E. Branch takeoffs shall be 45-degree lateral wye, conical tee, or bellmouth type, or square-to-round dovetail type. Other takeoff types shall not be used.
- F. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. For duct pressure classification less than 2" W.G., divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- G. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws. Flexible ductwork shall not be used in exposed areas.
- H. Use crimp joints with or without bead for joining round duct sizes 8-inch and smaller with crimp in direction of air flow.

- I. Longitudinal lock seams shall be double-locked and flattened to make tight joints.
- J. Make transverse joints, field connections, collar attachments, and flexible connection to ducts and equipment with sheetmetal screws or bolts and nuts. Do not use rivets and staples.
- K. Transverse joints shall be slip joint construction, except as described below.
- L. Except for duct 16-gauge and heavier, and duct 23-gauge or lighter, transverse joints in galvanized sheetmetal ductwork may be made with prefabricated galvanized gasketed frame and angle duct joint system by Ductmate, TDF, or TDC. Angles shall be at least 20-gauge. Secure angles to duct with screws or spot welds spaced as recommended by the joint manufacturer for the particular duct pressure class.
- M. Use double nuts and lock washers on threaded rod supports.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Provide openings in ductwork where required to accommodate thermometers and controllers. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- B. Ductwork shall be sealed in accordance with Seal Class A as defined in the SMACNA HVAC Duct Construction Standards.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Connect ductwork to diffusers as indicated on the Drawings.
- E. Connect ductwork to ceiling registers and grilles with 5 feet maximum flexible duct. Flexible duct runs shall be taut and shall have no changes in direction greater than 15 degrees. If necessary to prevent changes in direction greater than 15-degree hard duct elbows must be used to connect.
- F. For double-wall ductwork, install in accordance with manufacturer's instructions.
- G. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent or minimize construction dust from entering ductwork system.
- H. Ductwork Application Schedule:

AIR SYSTEM	MATERIAL
Supply and Return	Galvanized Steel
Toilet Exhaust	Galvanized Steel
Laundry Exhaust	Aluminum

3.2 ADJUSTING AND CLEANING

- A. Where necessary, clean duct system and force air at high velocity through duct to remove any accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- B. Where necessary, clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
- C. The Architect reserves the right to require full cleaning of all interior ductwork surfaces as part of this contract. It is imperative that construction dust entering the ductwork system be prevented or minimized at all times.

END OF SECTION

SECTION 239100
DUCTWORK ACCESSORIES

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Volume control dampers.
- B. Backdraft dampers.
- C. Flexible duct connections.
- D. Duct access doors.
- E. Duct test holes.
- F. Belt guards.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 REFERENCES

- A. Material, construction, and installation shall meet requirements of most recent editions of the following standards and references, except where more stringent requirements are specified or indicated on the Drawings.
 - 1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
 - 2. SMACNA - HVAC Duct Construction Standards.

1.4 REGULATORY REQUIREMENTS

- A. Comply with NFPA 90A and SMACNA standards.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230100.

- B. Submit manufacturer's installation instructions for fire dampers.

PART 2 – PRODUCTS

2.1 VOLUME CONTROL DAMPERS.

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 12 inches high and 48 inches wide.
- C. For duct sizes over 12 inches high or 48 inches wide, fabricate multi-blade dampers of opposed blade pattern. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.
- F. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.2 ACCEPTABLE MANUFACTURERS - BACKDRAFT DAMPERS

- A. Greenheck
- B. Arrow
- C. Ruskin
- D. Air Balance/American Warming

2.3 BACKDRAFT DAMPERS

- A. Gravity backdraft dampers, furnished with air moving equipment, may be air moving equipment manufacturer's standard construction.
- B. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16-gauge galvanized steel, with center pivoted blades of maximum 6-inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure; Ruskin Model BD2 or approved equal.

2.4 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.
- B. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum-density 20 oz per sq yd, approximately 3 inches wide, crimped into metal edging strip.
- C. Leaded vinyl sheet, minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.5 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.
- B. Review locations prior to fabrication.
- C. Fabricate rigid and close-fitting doors of 24-gauge galvanized steel with sealing gaskets and quick fastening locking devices. For insulated or lined ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors smaller than 12 inches square may be secured with sash locks.
- E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 × 48 inches. Provide an additional hinge for larger sizes.
- F. Access doors with sheet metal screw fasteners are not acceptable.
- G. Use Model ADH 1-2 by Ruskin or approved equal.

2.6 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.7 BELT GUARDS

- A. Fabricate solid sheet metal guards with angle iron frames securely fastened to the fan housing and fan base. Provide a framed opening opposite the fan shaft on all guards of approximately the same diameter as the fan pulley hub. Belt guards shall be shop primed and shop finished with machinery gray paint.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
 - B. Provide volume control dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing.
 - C. Provide backdraft dampers on all exhaust fans or exhaust ducts nearest to outside.
 - D. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment (unless manufacturer design specifically provides for the elimination of flexible connectors).
 - E. Provide duct access doors for inspection and cleaning in the following locations and of the indicated sizes:
 - 1. Automatic control dampers: 6" × 6", minimum.
 - 2. Manual volume dampers 2 sq.ft. and larger: 6" × 6", minimum.
 - 3. Inlet side to coils: 12" × 12", or larger.
 - 4. Suction and discharge sides of inline fans: 24" × 24", minimum, or maximum possible size based on duct size.
 - 5. At additional locations indicated on Drawings, or specified elsewhere: 12" × 12", minimum.
- Note: Generally access doors are not shown on the Drawings, but shall be provided in accordance with the above.
- F. Provide duct test holes where required for testing and balancing purposes.
 - G. Provide belt guards at all belt-driven equipment.

END OF SECTION

SECTION 239360

AIR OUTLETS AND INLETS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Diffusers.
- B. Registers.
- C. Grilles.
- D. Louvers.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 230100.
- B. Provide product data for items required for this project.
- C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
- D. Where Architect is to make color selection, submit color charts indicating available colors.
- E. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - DIFFUSERS, REGISTERS, AND GRILLES

- A. Price

- B. Metalaire
- C. Titus
- D. Krueger
- E. Tuttle & Bailey

2.2 DIFFUSERS, REGISTERS, AND GRILLES

- A. Provide diffusers, registers, and grilles of the types and sizes as indicated on the drawings and as specified herein.
- B. All square and rectangular supply air diffusers shall have diffusing vanes and shall be of the overall and neck size as indicated.
- C. Where indicated for diffusers and registers, neck size opposed-blade dampers shall be provided.
- D. Provide transitions where round ductwork is to be connected to square or rectangular necks, and where square or rectangular ductwork is to be connected to square or rectangular necks of different sizes.
- E. Provide diffusers, registers, and grilles specifically intended for the type of ceiling, wall or floor in which they are to be installed.
- F. All ceiling-mounted diffusers, registers, and grilles shall be of the overall size indicated on the Drawings.
- G. All ceiling-mounted diffusers, registers, and grills shall have off-white baked enamel finish.
- H. All wall-mounted diffusers, registers, and grilles shall have baked enamel finish of color to be selected by the Architect.
- I. All diffusers, registers, and grilles to be installed on exposed ductwork shall be finished with a factory primer suitable for field painting.
- J. Refer to the drawing schedules for diffuser, register, and grille types, sizes, and capacities.

2.3 ACCEPTABLE MANUFACTURERS - LOUVERS

- A. Greenheck
- B. Ruskin
- C. Construction Specialties
- D. Louvers and Dampers, Inc.
- E. Air Balance/American Warming

- F. Substitutions: Under provisions of Division 01.

2.4 LOUVERS

- A. Provide 4-inch deep louvers with blades on 37-degree slope, 0.081-inch thick channel frame, aluminum birdscreen with 1/2-inch square mesh; Model EDJ-401 manufactured by Greenheck.
- B. Fabricate of 0.081-inch thick extruded aluminum, welded assembly, with factory 0.3 mil baked enamel finish. Color by Architect.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install items in accordance with manufacturers' instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and ceiling plans.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 239750

BUILDING AUTOMATION SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The Building Automation System (BAS) Contractor shall furnish and install a complete and fully integrated building automation and automatic temperature control system, incorporating direct digital control (DDC) and electric devices for HVAC equipment monitoring and control, HVAC energy management, and specialty electrical system monitoring and control as herein specified and indicated on the drawings.
- B. The installation of the BAS shall be performed under the direct supervision of the BAS manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number, sequence of operations, and graphic display layout screens all bearing the name of the manufacturer.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 SCOPE

- A. The BAS Contractor shall provide all temperature sensors and transmitters, thermostats, controllers, automatic valves and dampers, valve and damper operators, control panels, electronic, and electric equipment, hardware, software, programming, and appurtenances, and other accessory equipment along with a complete system of electrical wiring to fulfill the intent of the specification and drawings and provide for a complete and operable system.
- B. All control equipment shall be fully proportioning, except as noted otherwise. All damper and valve actuators shall be electric.
- C. Coordinate with the Owner's operating personnel to receive scheduling requirements.
- D. Products, systems, and equipment which the BAS contractor shall integrate into, but which are not furnished or installed by the BAS Contractor, include (but are not necessarily limited to):

- 1. Variable frequency drives:

The variable frequency drive points including output frequency, speed, motor current, elapsed time meter, KWH meter, and fault status. All programming and set-up shall be the responsibility of the BAS Contractor.

1.4 INCIDENTAL WORK BY OTHERS

- A. The following incidental work shall be furnished by the Designated Contractor under the supervision of the BAS Contractor:
 - 1. The Heating Contractor shall:
 - a. Install automatic valves, flow stations, valved pressure taps, wells, and piping accessories and equipment that are specified to be supplied by the BAS Contractor.
 - b. Furnish and install all necessary service valves, and water, drain and overflow connections and piping.
 - c. Provide, on magnetic starters and/or motor controls furnished, all necessary auxiliary contacts, with buttons and switches in the required configurations.

1.5 ELECTRIC WIRING

- A. Except for power and control wiring specifically shown on the electrical drawings or called for in the electrical specifications, electric wiring, interlock wiring and wiring connections required for the installation of the BAS, shall be provided by the BAS Contractor. This requirement includes any required mounting and field wiring of control devices furnished with mechanical equipment.
- B. All wiring shall comply with the requirements of the electrical section of the specification (Division 26). In addition, the following shall apply:
 - 1. All wiring in mechanical rooms shall be EMT.

1.6 QUALITY ASSURANCE

- A. The BAS shall be designed and installed and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 150 miles of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.
- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of Building Automation Systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. The BAS shall comply with UL 916 PAZX and 864 UDTZ, European Community, and other subsystem listings as applicable, and herein specified, and be so listed at the time of bid.
- D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- E. The BAS manufacturer shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

- F. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels and extend new field panels on a previously installed network.

1.7 SUBMITTALS

- A. Provide submittals and product data in accordance with Section 230100.
- B. The following shall be submitted for approval:
 - 1. Control drawings with detailed wiring and/or control wiring diagrams, including:
 - a. Bill of materials for all components.
 - b. Sequence of operation for all systems.
 - c. Point names and addresses.
 - d. System riser diagrams.
 - e. Wiring diagrams.
 - 2. Panel layouts and name plate lists for all local control panels.
 - 3. Valve and damper schedules showing size, configuration, capacity and location of all equipment.
 - 4. Data cut sheets for all control system equipment and components.
- C. Upon project completion, submit operation and maintenance manuals. The as-built documentation listed below shall be accessible through a graphical icon button on the graphic home page, and shall also be provided in hard copy format (six hard copies will be required).
 - 1. Index sheet, listing contents in alphabetical order.
 - 2. Manufacturer's equipment parts list of all functional components of the system.
 - 3. Description of sequence of operations.
 - 4. As-built interconnection wiring diagrams.
 - 5. Operator's manual.
 - 6. Trunk cable schematic showing remote electronic panel locations, and all trunk data.
 - 7. List of connected data points, including panels to which they are connected and input device (i.e. sensors, etc.).
 - 8. Conduit routing diagrams.
 - 9. All other pertinent information necessary for proper system operation and maintenance.

1.8 ACCEPTABLE PROCEDURE

- A. Upon completion of system(s) calibration, the BAS Contractor shall startup the system and perform all necessary trouble-shooting and run diagnostic tests to ensure proper operation. The BAS Contractor shall be responsible for generating all software and entering all database information necessary to perform the sequence of operations and specified software routines. An acceptance test in the presence of the Owner's representative or Engineer shall be performed.
- B. The BAS Contractor and the Testing and Balancing Agency shall check the BAS for conformance to Drawings and Specifications including location of components and correct

sequence of operations. The Testing and Balancing Agency shall report the results in writing to the Engineer. The Engineer and BAS Contractor shall do a performance test of the system including checking the sequence of operations.

- C. The Mechanical Contractor and BAS Contractor shall instruct the Owner in the proper operation of the mechanical systems as specified.

1.9 WARRANTY

- A. The BAS indicated on the drawings and herein specified, shall be warranted to be free from original defects in both material and workmanship for a period of one (1) year of normal use and service, excepting damages from other causes. This warranty shall become effective starting the date of Substantial Completion.

1. Provide all repair and maintenance services (scheduled and unscheduled), materials, and equipment necessary for the successful operation of the entire BAS system for a period of one year after date of Substantial Completion. This shall include all adjustment, required testing, and repair of all systems, all computer equipment, transmission equipment, sensors, control devices, and appurtenances.
2. On-line support services shall be provided by the BAS Contractor to remotely monitor and control the BAS. This remote service shall be provided within 2 hours of the time that a problem is reported. This coverage shall include normal business hours, after business hours, weekends, and holidays.
3. If the reported problem cannot be resolved on-line by the local office, the national office of the BAS manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that a problem is reported.
4. Prior to completion of the warranty period, the BAS Contractor shall submit to the Owner a proposal for continuation of scheduled maintenance on an annual basis.

PART 2 – PRODUCTS

2.1 HVAC INSTRUMENTATION AND CONTROLS

- A. Automatic temperature control systems shall be DDC type capable of being connected to the campus Johnson Controls Metasys Energy Management and Control System (EMCS) system in the future using existing energy management fibers on the campus fiber backbone. Control down to the terminal unit shall be DDC. Software and point definition shall match existing systems. DDC systems shall be fully compatible with existing campus EMCS, capable of sharing all data and commands in real time with all existing controllers, workstations and user interfaces.

- B. Acceptable Manufacturers:

1. Johnson Controls
Contact: Greg Halpern
Tel: 413-207-1707
Email: Gregory.halpern@jci.com

2.2 CONTROL DEVICES

- A. Furnish control devices as required to fulfill the specified sequences of operation.

PART 3 – EXECUTION

3.1 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
 - 1. Construct and maintain project schedule.
 - 2. On-site coordination with all applicable trades and subcontractors.
 - 3. Authorized to accept and execute orders or instructions from Owner/Engineer.
 - 4. Attend project meetings as necessary to avoid conflicts and delays.
 - 5. Make necessary field decisions relating to this scope of work.
 - 6. Coordination/Single point of contact.

3.2 START-UP

- A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that all systems are operable from local controls in the specified failure mode, upon panel failure or loss of power.
- B. Provide any recommendation for system modification in writing to the Owner/Engineer. Do not make any system modification, including operating parameters and control settings, without prior approval.

3.3 ADJUSTING AND CLEANING

- A. Start-Up: Start-up, test, and adjust control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Schedules: Coordinate with the Owner's operating personnel to receive scheduling and trend log requirements.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- D. Final Adjustment: After completion of installation, adjust thermostats, sensors, control valves, motors and similar equipment provided as work of this section.

1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

3.4 TRAINING AND CLOSEOUT PROCEDURES

- A. The Contractor shall provide a factory trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The BAS Contractor shall provide all "students" with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.
- B. Owner's Instructions: Provide services of manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of control systems.
 1. Provide a minimum of 16 on-site hours of training for Owner's designated operating and maintenance personnel, in multiple sessions (up to 4 sessions total) at intervals convenient to the Owner. Training shall include, but is not limited to:
 - a. Explanation of drawings, operations and maintenance manuals.
 - b. Walk-through of the job to locate control components.
 - c. Operator workstation and peripherals.
 - d. DDC controller and ASC operation/function.
 - e. Operator control functions including graphic generation and field panel programming.
 - f. Explanation of adjustment, calibration and replacement procedures.
 - g. Student binder with training modules.
 2. Schedule instruction with Owner; provide at least 7-day notice to Contractor and Engineer of training dates.
- C. All training shall be coordinated with the Mechanical Contractor. Refer to Specification Section 15010.
- D. Since the Owner may require personnel to have more comprehensive understanding of the BAS, additional training must be available from the BAS Contractor. If such training is required by the Owner, it will be contracted at a later date.

PART 4 – EXECUTION (SEQUENCE OF OPERATIONS)

4.1 SEQUENCE OF OPERATIONS

- A. As indicated on the drawings.

END OF SECTION

SECTION 239800
INSTRUMENTATION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Pressure gauges and gauge cocks.
- B. Thermometers and thermometer wells.
- C. Combination temperature and pressure test plugs.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 SUBMITTALS

- A. Submit under provisions of Section 230100.
- B. Product Data: Include list which indicates use, operating range, total range and location for manufactured components.

PART 2 – PRODUCTS

2.1 PRESSURE GAUGES

- A. ASME/ANSI B40.1, 4-1/2-inch diameter drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, one percent mid-scale accuracy, scale calibrated in psi, Model No. 450 manufactured by Trerice, or approved equal. Pressure gauges shall have ranges of 0-60 psig.

2.2 PRESSURE GAUGE COCKS

- A. Gauge cocks shall be tee or lever handle, brass for maximum 150 psig.

2.3 STEM TYPE THERMOMETERS

- A. ASTM E1, 9-inch scale, spirit: blue colored, organic lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, 3-1/2-inch brass stem, 2 percent of scale accuracy scale calibrated in degrees F, Model BX91403½ manufactured by Terice or approved equal. Thermometers shall have ranges of 40-240 deg. F, except chilled water system thermometers shall have range of 0 - 100 deg. F.

2.4 THERMOMETER SUPPORTS

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

2.5 COMBINATION TEMPERATURE AND TEST PLUGS

- A. Provide combination temperature and pressure test plugs by Peterson Equipment Company (Petes Plug) or Sisco, Inc. (P/T Plugs).
- B. Plug shall be 1/4" or 1/2" NPT, constructed of solid brass with a Nordel valve core suitable for temperatures up to 350 deg. F. Plug shall be rated zero leakage from vacuum to 1000 psig.
- C. Provide extension fitting for each plug suitable for use with 2-inch maximum pipe insulation.
- D. Provide gauge test kit consisting of the following items:
 - 1. Two (2) 3½" dial face gauges 0-100 psi and 0-231 feet.
 - 2. Two (2) gauge adapters with 1/8" O.D. probe.
 - 3. Two (2) 5-inch stem pocket testing thermometers ranges 25-125 deg. F; 0-220 deg. F.
 - 4. One (1) carrying case.
 - 5. Two (2) 4-foot length of flexible hose with adapters.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide pressure gauges with taps and petcocks elsewhere in the system as indicated on the Drawings.

- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Install thermometers in piping systems as indicated on the Drawings.
- D. Install combination temperature and pressure test plugs adjacent to controls system thermostat, transmitter, or sensor sockets. (Note: Combination temperature and pressure test plugs adjacent to control system sockets are not indicated on the Drawings, coordinate with the ATC Contractor for locations.) Install other combination temperature and pressure test plugs as indicated on the Drawings.
- E. Coil and conceal excess capillary on remote element instruments.
- F. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- G. Install gauges and thermometers in locations where they are easily read from normal operating level.
- H. Install combination temperature and pressure test plugs as indicated on the Drawings.

END OF SECTION

SECTION 239900

TESTING, ADJUSTING AND BALANCING

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Testing, adjustment, and balancing of air systems.
- B. Measurement of final operating condition of HVAC systems.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary General Conditions and other Division 01 Specification sections, apply to work of this Section.
- B. All related Specification sections shall be used in conjunction with this Section.

1.3 SPECIAL REQUIREMENTS

- A. Employ an independent testing and balancing firm, acceptable to and approved by the Architect, to test, adjust, and balance the air handling systems and hydronic systems.
- B. The temperature control system must be completely installed before balancing is started. Calibrate the temperature control system simultaneously with the balancing operation.
- C. Prior to beginning any testing, adjusting and balancing, schedule a pre-balancing meeting with the Architect, Owner, General Contractor, Mechanical Contractor, and ATC Contractor to schedule the balancing and testing, adjusting and balancing procedures.
- D. Make any necessary changes in fan speeds to obtain design system conditions. Change the size of drives, sheaves, and belts as required.
- E. Furnish qualified workmen as required to cut openings in ducts for air readings, adjust fan speeds as directed and do such other work as required to assist in balancing the systems. Cut neat round holes with no sharp edges in belt guards.
- F. Prior to the start of balancing, check the rotation of all fans. Check to verify that all dampers are free to open and close.
- G. All filters must be checked and replaced if operated during construction, before commencing balancing so as not to create excessive resistance to the system.
- H. Test, adjust, and put in service all systems and make all adjustments as required to make them operate as specified. Put mechanical equipment specified herein in operation in the presence of the Architect and Owner (if desired by the Architect and Owner) with forty-eight (48) hours

notice given for each start-up. Give instructions to a designated representative(s) of the Owner, in the operation and routine maintenance of all parts of the various systems.

1.4 REFERENCES

- A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. ASHRAE - 1995 Applications Handbook: Chapter 34, Testing, Adjusting, and Balancing.
- C. NEBB - Procedural Standards for Building Systems Commissioning; Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

1.5 SUBMITTALS

- A. Submit shop drawings under provisions of Section 230100.
- B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- C. Prior to commencing work, submit draft reports indicating procedures, sample report forms, testing, adjusting and balancing data required.
- D. Submit draft copies of completed balancing report for review prior to final acceptance of project.
- E. After Architect review, make requested system adjustments and provide final copies of report for Architect and for inclusion in operating and maintenance manuals.
- F. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.6 REPORT FORMS

- A. Submit reports on AABC National Standards for Total System Balance forms, or reporting forms in a format approved by NEBB.
- B. Forms shall include the following information:
 - 1. Title page:
 - a. Company name
 - b. Company address
 - c. Company telephone number
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor

- i. Project altitude
2. Instrument list:
 - a. Instrument
 - b. Manufacturer
 - c. Model
 - d. Serial number
 - e. Range
 - f. Calibration date
3. Energy recovery units:
 - a. Location
 - b. Manufacturer
 - c. Model
 - d. Supply air flow, design and actual
 - e. Exhaust air flow, design and actual
 - f. Supply air temperature, entering and leaving heat exchanger, specified and actual
 - g. Exhaust air flow, entering and leaving heat exchanger, specified and actual
 - h. Air relative humidity, entering heat exchanger on supply and exhaust sides, specified and actual
 - i. Total static pressure, design and actual
 - j. External static pressure, design and actual
 - k. Inlet pressure
 - l. Discharge pressure
 - m. Fan RPM
4. Fan data:
 - a. Location
 - b. Manufacturer
 - c. Model
 - d. Air flow, specified and actual
 - e. Total static pressure, design and actual
 - f. External static pressure, design and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Fan RPM
5. Electric motor data:
 - a. Manufacturer
 - b. HP/BHP
 - c. Phase, voltage, amperage; nameplate, actual, no load.
 - d. RPM

- e. Service factor
 - f. Starter size, rating, heater elements
6. V-belt drive data:
- a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave, diameter and RPM
 - f. Center-to-center distance, maximum, minimum, and actual
7. Duct traverse data:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
8. Heating coil data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Air pressure drop, design and actual
 - g. Entering air temperature, design and actual
 - h. Leaving air temperature, design and actual
9. Balancing valve data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Model
 - f. Size
 - g. Design flow rate
 - h. Design pressure drop

- i. Actual flow rate
- j. Actual pressure drop
- k. Valve calibrated setting

1.7 PROJECT RECORD DOCUMENTS

- A. Submit record documents under provisions of Section 230100.
- B. Accurately record actual locations of balancing dampers and balancing valves and rough setting.

1.8 QUALITY ASSURANCE

- A. Testing and balancing firm shall be a company specializing in the testing, adjusting, and balancing of systems specified in this section with a minimum three years documented experience certified by AABC and/or NEBB. Perform Work under the supervision of an AABC and/or NEBB Certified Test and Balancing Engineer.
- B. Total system balance shall be performed in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance; NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems; NEBB Procedural Standards for Building Systems Commissioning; and ASHRAE - 1995 Applications Handbook.

1.9 SEQUENCING AND SCHEDULING

- A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Before commencing work, verify that systems are complete and operable. Ensure the following:
 - 1. Equipment is operable and in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Correct fan rotation.
 - 7. Volume dampers are in place and open.

8. Coil fins have been cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage has been minimized.
12. Hydronic systems have been flushed, filled, tested, and vented.
13. Proper strainer baskets are clean and in place.
14. Service and balance valves are open.

- B. Report any defects or deficiencies noted during performance of services to Architect.
- C. Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.

3.2 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- B. Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

- A. Adjust air handling systems to plus or minus 5 percent for supply systems and plus or minus 10 percent for return and exhaust systems from figures indicated.
- B. Adjust hydronic systems to plus or minus 10 percent of design conditions indicated.

3.4 ADJUSTING

- A. Recorded data shall represent actually measured, or observed condition.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- F. Check and adjust all HVAC systems approximately six months after final acceptance and submit revised version of original report.

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters. Provide any necessary additional dampers, splitters, etc., as required to obtain correct air balance, and as directed by the Architect.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive, sheave, and belt changes as required, and as directed by the Architect. Vary branch air quantities by damper regulation.
- G. Furnish qualified workmen as required to cut openings in ducts for air readings. Holes shall be cut as small as possible and resealed airtight upon completion of system balancing.
- H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- L. Where modulating dampers are provided, take measurements and balance at extreme conditions.
- M. Upon completion of system balancing, replace all throwaway filters with new filters and clean all permanent metallic filters and reinstall.

END OF SECTION

