

## SECTION 15500 - BASIC MECHANICAL REQUIREMENTS

### PART I. - GENERAL

#### A. GENERAL CONDITIONS:

1. The stipulations and conditions stated in this section, together with all provisions of the "Instructions to Bidders", "General Conditions", "Supplemental General Conditions", and "Special Conditions", hereinbefore set forth, shall apply to this and the other sections of Division 15.

#### B. GENERAL REQUIREMENTS:

1. The General Requirements hereinafter listed apply to the Mechanical Work Division. If there is any conflict between the General Requirements and the General Conditions, the General Conditions shall take precedence.

#### C. ALTERNATES:

1. Carefully examine all alternates at the back of this specification to determine if any work described under the Mechanical Section will be affected thereby.

#### D. INTENT:

1. The intent of these drawings and specifications are to describe the installation of a complete, fully adjusted, and operational system. Therefore, any items shown on drawings and not specifically called for in the specifications, or any items specified and not specifically indicated or detailed on the drawings, or any items neither specified or shown, but which are reasonably incidental to and commonly required to make a complete job, will be furnished and installed by the Mechanical Contractor at his own expense.

#### E. DEFINITIONS:

1. The Mechanical Contractor shall provide all supervision, labor, material equipment, machinery, plant, and any and all other items necessary to complete the mechanical systems. All items of equipment are specified in the singular; however, the Mechanical Contractor shall provide the number of items of equipment as indicated on the drawings, and as required for complete systems.

Where the word "provide" is used, it shall mean "furnish and install complete and ready to use."

#### F. VISIT TO THE SITE:

1. The Mechanical Contractor shall visit the site before submitting his bid so as to be thoroughly familiar with the job conditions and/or peculiarities. No extra payment will be allowed for anything which could have been anticipated from a visit to the site.

#### G. REGULATORY REQUIREMENTS

1. All work under this section shall be accomplished in strict accordance with State codes. Where these plans and specifications conflict with such codes, the codes shall govern. The Mechanical Contractor shall notify the architect or engineer of such conflicts in writing prior to receipt of bids.

G. PERMITS AND FEES:

1. The Mechanical Contractor shall make all necessary arrangements, obtain all necessary approval, obtain all permits and pay fees required for the installation of any of the work covered under the Mechanical Work Division of the specifications. Any fees required by any utility companies or municipal authorities for the final connections for these services shall be paid by the Mechanical Contractor under whose work such services appear. Before the job is certified as substantially complete, a certificate of approval from all authorities involved must be obtained and turned over to the Architect/Engineer.

H. DRAWINGS AND SPECIFICATIONS:

1. The Mechanical Drawings and Specifications are intended to cover all the work enumerated under the respective headings. The drawings are diagrammatic only. No contractor shall take advantage of conflict or error between drawings and specifications, or between general drawings and mechanical, plumbing and/or electrical drawings, but shall request a clarification of such from the Architect/Engineer, should this condition exist. If there is insufficient time to issue an addendum for this clarification, the Mechanical Contractor shall figure on the most expensive of the items in conflict.
2. The Mechanical Contractor shall refer to the architectural and structural drawings and specifications for the general construction of the building, for floors and ceiling heights, for locations of walls, partitions, beams, etc., and shall be guided accordingly for setting of all sleeves, inserts and equipment. No Contractor shall under any circumstances scale drawings for the location of equipment. The Mechanical Contractor shall verify the locations of all utility services.
3. The Mechanical Contractor shall keep at least one set of corrected shop and design drawings at the site. Drawings are to be current, denoting approved modifications and actual installed departure. Submit drawings to Architect/Engineer before final payment is made.

I. SUPERVISION:

1. The Mechanical Contractor performing the work specified shall be required to employ a qualified superintendent or foreman to continuously supervise the installation of their work, with authorization to act as agent Contractors. He shall be capable of checking layouts, coordinating and supervising the work, establishing grades and levels, and locating chases, openings, hangers, inserts, sleeves, etc.

PART II. - PRODUCTS

A. STANDARD PRODUCTS:

1. Unless otherwise indicated in writing by the Architect/Engineer, the materials to be provided under this specification shall be standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest design. All items of the same type or rating shall be identical.

B. SUBMITTAL:

1. The Mechanical Contractor shall submit, for approval, detailed shop drawings on all major equipment and where requested. No materials or equipment may be delivered to the job site or installed until the Mechanical Contractor has in his possession the approved shop drawing for the particular material or equipment. The Mechanical Contractor shall furnish the number of copies required by the General or Special Conditions of the contract, but no case less than six (6) copies.
2. Submitted material shall be properly labeled indicating specific service for which material or equipment to be used, section and article number of specifications governing, Contractor's name, and name of job.
3. Approval of equipment will not relieve the Mechanical Contractor of compliance with the specifications even if such approval is made in writing, unless the attention of the Engineer is called to the non-complying features by letter accompanying the submittal data. Approval of submittal data by the Engineer shall not be construed as a complete check of approval of detailed dimensions, weights, gauges, and similar details with the proposed articles. The conformance with the necessary coordination between the various other contractors and suppliers shall be solely the responsibility of the Mechanical Contractor and with no additional expense to the owner.

C. SUBSTITUTIONS:

1. Manufacturer's lists are to establish a standard of quality and not intended to limit the selection to these manufacturers. All materials and equipment which are essential and have not been specified or shown shall be new and of the highest grade and quality. Free from defect or other imperfections. It should be understood that where the words "furnished and installed" are used, it is intended that the Mechanical Contractor shall purchase and install all materials required.
2. All materials and equipment proposed as substitutes for these specified shall require a ten (10) day prior approval from the Engineer prior to the bid date. No substitutions will be allowed after the ten (10) day period before the bid date.

D. PRODUCT HANDLING:

1. Equipment and materials shall be properly stored, adequately protected, and carefully handled to prevent damage before and during installation. Equipment and materials shall be handled, stored and protected in accordance with the manufacturer's recommendations and as approved by the Architect/Engineer. Equipment installed with a factory finish shall be fully protected during construction and shall be maintained free of dust, dirt, and foreign matter. Dents and other surface damage shall be repaired or replaced to the satisfaction of the Architect/Engineer at no additional cost to the Owner.
2. The Mechanical Contractor shall clean up and remove from the job site all waste materials,

packaging, crating, and refuse resulting from his work on a daily basis.

E. MATERIALS AND WORKMANSHIP:

1. The Mechanical Contractor shall perform a first class job, both in material and workmanship. None other will be accepted. Deviations from either will be corrected by the Mechanical Contractor, at Mechanical Contractor's expense.
2. The Material used throughout the work, except when otherwise noted, shall be new and of the best of its kind. No substitutes shall be used unless approved by the Architect/Engineer. All work shall be executed with a maximum speed consistent with safety and good workmanship.
3. Any equipment furnished by the Mechanical Contractor that is larger than those indicated on the drawings and described in these specifications or have different electrical characteristic than those indicated on equipment schedules on the drawings, the increase in cost to the Electrical Contractor for larger wires, conduit, circuit breakers, switches, etc. or for changes in work already installed shall be borne by the instigating contractor.

PART III. - EXECUTION

A. EXCAVATION AND BACKFILL:

1. The Mechanical Contractor shall perform any and all trench and pit excavation and backfilling required for the installation of his work. Trenches shall be made with the sides vertical and shall be shored where necessary for the protection of men and equipment. All excavation work shall be done in a careful manner to avoid damage to footers and foundations. The backfilling shall be placed in layers not exceeding 4 inches in depth, wetting each layer as it is placed, and thoroughly compacting each layer with mechanical tamper or other approved means. Any damage done during excavation and backfilling operations to roads, sidewalks, curbs, shrubs, sod, footers, foundations, etc. shall be replaced to its condition prior to construction, at no expense to the owner.

B. SCAFFOLDING, RIGGING, AND HOISTING:

1. The Mechanical Contractor shall furnish all necessary scaffolding, staging, rigging and hoisting required for the completion of his work. All such scaffolding, etc., shall be removed from the premises when its use is no longer required on the job.

C. CUTTING AND PATCHING:

1. The Mechanical Contractor shall provide all cutting and patching necessary to install the work specified in this section. The patching shall match adjacent surfaces.
2. No structural member shall be cut without the approval of the engineer, and all such cutting shall be done in a manner directed by him.

D. EQUIPMENT SPACE AND ARRANGEMENT:

1. The equipment shall fit into the space allotted and shall allow adequate clearance for entry, installation, replacement, servicing, and maintenance. The Mechanical Contractor shall coordinate the work to ensure that equipment may be moved into place without altering building components or other installations. Access space shall not be less than the equipment manufacturer's requirements.
2. These drawings indicate the extent and general arrangement of equipment, piping, and ductwork. If any departures are deemed necessary by the Mechanical Contractor, details of such departures and the reasons therefore shall be submitted to the Architect/Engineer for approval as soon as practicable and within 30 days after award of the contract. No departure shall be made without written approval of the Architect/Engineer.

D. DAMAGE TO WORK ALREADY IN PLACE:

1. The Mechanical Contractor shall assume full responsibility for any damage done by him, his agents or employees, to any work already in place. Any such damage done shall be repaired at the contractor's expense by mechanics skilled at their respective trades, to the approval of the Architect/Engineer.

E. JURISDICTION OF WORK:

1. It may become necessary for the Mechanical Contractor to furnish labor or materials which is not generally accepted as part of this trade. In cases of this type, he shall contract the work, or shall furnish materials and employ workmen of the trade involved in order not to cause any delay or stoppage of work caused by infringement of trade agreements as to jurisdiction, alleged or actual.

F. COORDINATION WITH OTHER TRADES:

1. All work shall be coordinated with other trades involved in the construction project. All work shall be carefully laid out in advance to coordinate architectural, structural, mechanical, plumbing and electrical features of construction. The Contractor shall verify at the site all locations, grades, elevations, and utility service connections indicated. Any conflicts due to lack of proper coordination shall be brought to the attention of the Architect/Engineer for resolution. The Mechanical Contractor shall make required changes or relocations at no additional cost to the Owner.
2. Installation, inspection, and testing of work above ceilings shall be completed and approved by the Architect/Engineer prior to installation of the specified finished ceilings. However, ceiling suspension system may be installed as required for coordination.
3. The Mechanical Contractor shall consult with the other trades at the start of the work and periodically thereafter, as required to properly coordinate the various items of work, and to avoid interferences. Should any interferences of any nature develop as the work progresses, such interferences shall be resolved and eliminated as directed. The cost of any work directed shall be borne by the subcontractor or contractors directed to do this work.

G. DIVISION OF WORK:

1. This paragraph is intended to show exactly the point of division of work between the Electrical Division and the Mechanical Division.

2. All equipment covered in the Mechanical Division of the specifications shall be furnished, mounted, and aligned under the Mechanical Division. All disconnect switches, starters, conduit, wire for this equipment shall be furnished and installed under the Electrical Division. This includes wiring to the equipment from switches, starters and disconnects.
3. All final electrical connections to equipment covered in the Mechanical Division of the specifications shall be completed under the Mechanical Division.

H. EQUIPMENT INSTALLATION:

1. Final connections to equipment, including pipe, duct, and controls, shall be provided under applicable sections of this Division, unless otherwise specified or indicated.
2. Manufacturer's Instructions: Equipment shall be installed as recommended by the manufacturer to conform to the requirements of the particular application, in accordance with these drawings and specifications.

I. OPERATION AND MAINTENANCE MANUALS:

1. One complete manual as outlined herein shall be submitted for approval before conducting instruction sessions in operation, before systems or equipment tests are performed, and before final or beneficial occupancy.
2. Manuals shall have rigid covers and index tabs for each major piece of equipment, auxiliaries, and systems. The following shall be inscribed on the cover: the words "OPERATION AND MAINTENANCE MANUAL," the name and location of the building, the name of the section, such as "Heating" and the name of the Mechanical Contractor. Two copies of each approved manual shall be submitted to the Owner and one copy shall be submitted to the Architect-Engineer.
3. Each piece of equipment shall be listed and identified with the same name, mark, number, or other identification as noted or scheduled in the contract documents.
4. Manuals shall include the following:
  - a. Complete operating installations, covering start-up and shutdown for all components installed.
  - b. Legible copies of all shop drawings. Any comments incorporated in "as-noted" approvals of shop drawings shall be recorded on the drawings included in the manuals.
  - c. All equipment maintenance and service manuals.
  - d. A complete parts list for each piece of equipment.
  - e. All descriptive literature for the equipment.
  - f. Operating characteristics, performance data, ratings, and curves for each piece of equipment such as condensers, fans, and air handling units.
  - g. Internal wiring and control diagrams.

- h. Automatic temperature control diagrams, part descriptions and numbers, and sequences of operation. Drawings shall be neatly folded and inserted in a separate clear plastic binder. The plastic binders shall be bound in the back of each manual.
- i. Final testing and balancing reports.
- j. All other information pertinent to the maintenance and servicing of equipment and systems provided in the project.
- k. Name, address, and telephone number for service on each manufacturer's equipment.

J. OPERATING INSTRUCTIONS:

- 1. After all equipment and services are in operation, and the operation and maintenance manuals are available, an instruction and training session shall be conducted for the Owner's operating personnel.
- 2. Instruction sessions shall be conducted during the Owner's normal working periods, and at times and locations satisfactory to the Owner.

K. EQUIPMENT START-UP:

- 1. No equipment shall be placed in operation until it has been inspected by a qualified representative of the manufacturer and certified to be ready for operation. The manufacturer's representative shall supervise the start-up operation and shall be responsible for all adjustments required to meet design conditions. Such services shall be at no additional cost to the Owner.

L. GUARANTEE:

- 1. The Mechanical Contractor shall present to the Owner a written guarantee covering his work, including all equipment, material and workmanship. This guarantee shall be against all defects in any of the above work, and shall run for a period of one (1) year from the date of written acceptance of the Contractor's work.
- 2. Any defective work, equipment, material and/or workmanship that develops within the guarantee period, which is not caused by ordinary wear or abuse by other persons, shall be replaced by the Mechanical Contractor without cost to the Owner.

M. FINAL INSPECTION:

- 1. When the entire contract has been completed and the work is ready for final inspection, the Architect/Engineer or his duly authorized representative will make the inspection. At the time of inspection, the Mechanical Contractor shall demonstrate to the Architect/Engineer that the various systems and pieces of equipment have been adjusted to operate in accordance with the requirements of the contract.

N. FINAL PAYMENTS:

- 1. All final payments are contingent upon all necessary certificates and/or approvals cited

above, together with the written guarantee being presented to the Owner.

END OF SECTION 15500

## SECTION 15501 - HANGERS AND SUPPORTS

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes hangers and supports for mechanical systems piping and equipment.

#### C. QUALITY ASSURANCE

1. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code-Steel."
  - a. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

### PART II - PRODUCTS

#### A. PIPE HANGERS AND SUPPORTS

1. Hangers: Carbon steel, adjustable, clevis.
2. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
3. Vertical Support: Steel riser clamp.
4. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
5. Shield for Insulated Piping 2 Inches and Smaller: 18 gage galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support.

#### B. HANGER RODS

1. Steel Hanger Rods: Threaded both ends or continuous threaded.

#### C. FLASHING

1. Metal Flashing: 26 gage galvanized steel.
2. Lead Flashing: 5 lb/sq ft sheet lead for waterproofing.
3. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

#### D. SLEEVES

1. Sleeves for Pipes: Form with schedule 40, galvanized steel pipe.

2. Sleeves for Round Ductwork: Form with galvanized steel.
3. Sleeves for Rectangular Ductwork: Form with galvanized steel or wood.

#### E. MISCELLANEOUS MATERIALS

1. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Grout: ASTM C 1107, Grade B, nonshrink, nonmetallic.
  - a. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
  - b. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
  - c. Water: Potable.
  - d. Packaging: Premixed and factory-packaged.

#### F. ATTACHMENTS

1. Power-Actuated Drive Pin Fasteners: Powder-actuated-type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Permitted in concrete over 4 inches thick.
2. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Permitted in concrete over 4 inches thick.
3. Weld: Type 22.
4. Beam clamps: Types 20, 21, 28 or 29.

### PART III - EXECUTION

#### A. HANGERS AND SUPPORTS INSTALLATION

1. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
2. Install building attachments within concrete or to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.
3. Install hangers and support complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
4. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

6. Support horizontal piping as follows:

PIPE SIZE	MAX. HANGER SPACING	HANGER DIAMETER
1/2 to 1-1/4 inch	6'-6"	3/8"
1-1/2 to 2 inch	10'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
PVC	6'-0"	3/8"

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

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

9. Use hangers with 1-1/2 inch minimum vertical adjustment.

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

11. Support riser piping independently of connected horizontal piping.

12. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

#### B. EQUIPMENT BASES AND SUPPORTS

1. Provide equipment bases of concrete.

2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

#### C. EQUIPMENT SUPPORTS

1. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

2. Grouting: Place grout under supports for equipment, and make a smooth bearing surface.

#### D. METAL FABRICATION

1. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

2. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

3. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds.

#### E. FLASHING

1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate

weather or waterproofed walls, floors, and roofs.

2. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

F. SLEEVES

1. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
2. Design hangers without disengagement of supported pipe.
3. Extend sleeves through floors one inch above finished floor level. Calk sleeves full depth and provide floor plate.
4. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with fire stopping insulation and calk seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
5. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

END OF SECTION 15501

## SECTION 15502 - MOTORS

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes basic requirements for motors. It includes motors that are factory-installed as part of equipment and appliances as well as field-installed motors.

#### C. QUALITY ASSURANCE

1. Comply with NFPA 70, "National Electrical Code."
2. NRTL Listing: Provide NRTL listed motors.
  - a. Term "Listed": As defined in "National Electrical Code," Article 100.
  - b. Listing Agency Qualifications: "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
3. Comply with NEMA MG 1, "Motors and Generators."
4. Comply with UL 1004, "Motors, Electric."

### PART II - PRODUCTS

#### A. MOTORS, GENERAL

1. General: Requirements below apply to motors covered by this Section except as otherwise indicated.
2. Motors 1/2 HP and Larger: Single-phase.
3. Motors Smaller Than 1/2 HP: Single-phase.
4. Frequency Rating: 60 Hz.
5. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
  - a. 120 V Circuit: 115 V - motor rating.
  - b. 208 V Circuit: 200 V - motor rating.
6. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
7. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings.

Provide motors rated for continuous duty at 100 percent of rated capacity.

8. Temperature Rise: Based on 40 deg C ambient except as otherwise indicated.
9. Enclosure: Open dripproof.

#### B. SINGLE-PHASE MOTORS

1. General: Conform to the following requirements except as otherwise indicated.
2. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.
  - a. Permanent Split Capacitor.
  - b. Split-Phase Start, Capacitor-Run.
  - c. Capacitor-Start, Capacitor-Run.
3. Shaded-Pole Motors: Use only for motors smaller than 1/20 hp.
4. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.
5. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

### PART III - EXECUTION

#### A. INSTALLATION

1. General: The following requirements apply to field-installed motors.
2. Install motors in accordance with manufacturer's published instructions.

#### B. COMMISSIONING

1. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with the commissioning of the equipment for which the motor is a part.
2. Report unusual conditions.
3. Correct deficiencies of field-installed units.

END OF SECTION 15502

## SECTION 15503 - MECHANICAL IDENTIFICATION

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes mechanical identification materials and devices.

#### C. QUALITY ASSURANCE

1. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

#### D. SEQUENCING AND SCHEDULING

1. Coordinate installation of identifying devices after completion of covering and painting where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

### PART II - PRODUCTS

#### A. MATERIALS

1. Color: Unless specified otherwise, conform with ANSI/ASME A13.1.
2. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.
3. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
4. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inch wide by 4 mil thick, manufactured for direct burial service.

### PART III - EXECUTION

#### A. PREPARATION

1. Degrease and clean surfaces to receive adhesive for identification materials.
2. Prepare surfaces in accordance with manufacturers recommendations.

#### B. INSTALLATION

1. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners.

2. Plastic Tape Pipe Markers: Install complete around pipe in accordance with manufacturer's instructions.
3. Underground Plastic Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.
4. Equipment: Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with plastic tags.
5. Controls: Identify control panels and major control components outside panels with plastic nameplates.
6. Piping: Identify piping, concealed or exposed, with plastic tape pipe markers. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 15503

## **SECTION 15507 - DUCTWORK INSULATION**

### **PART I - GENERAL**

#### **A. RELATED DOCUMENTS:**

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

#### **B. SUMMARY:**

1. This Section includes duct and plenum insulation.

#### **C. QUALITY ASSURANCE:**

1. Fire Performance Characteristics: Conform to the following characteristics for insulation including linings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
  - a. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
  - b. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

### **PART II - PRODUCTS**

#### **A. MANUFACTURERS:**

1. Acceptable Manufacturers:
  - a. Duct Liner:
    - (1) Armstrong
    - (2) CSG Ultraliner
    - (3) Johns Manville

#### **B. DUCT LINER:**

1. All supply and return ductwork shall be completely insulated.
2. Rectangular ductwork shall be lined with one-inch thick, 1.5 lb. per cubic foot density, duct liner.
3. Exhaust air duct do require insulation.

### **PART III - EXECUTION**

#### **A. INSTALLATION:**

1. Insulation shall be installed according to manufacturer's recommendations with approved adhesive.

END OF SECTION 15507

## SECTION 15510 - HYDRONIC PIPING

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes hydronic piping systems.

### PART II - PRODUCTS

#### A. EQUIPMENT DRAINS AND OVERFLOWS

1. Copper Tubing: ASTM B88, Type K, hard drawn. Fittings: ANSI/ASME B16.23 cast brass or ANSI/ASME B16.29 solder wrought copper. Joints: ANSI/ASTM B32, solder, Grade 95TA.

### PART III - EXECUTION

#### A. PREPARATION

1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
2. Remove scale and dirt on inside and outside before assembly.
3. Prepare piping connections to equipment with flanges or unions.
4. After completion, fill, clean, and treat systems.

#### B. INSTALLATION

1. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
2. Install piping to conserve building space, and not interfere with use of space and other work.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
5. Provide clearance for installation of insulation, and access to valves and fittings.
6. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
7. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

8. Prepare pipe, fittings, supports, and accessories for finish painting.

9. Install valves with stems upright or horizontal, not inverted.

C. APPLICATION

1. Install unions downstream of valves and at equipment or apparatus connections.

END OF SECTION 15510

## SECTION 15511 - GAS PIPING

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes piping, specialties, and accessories for natural gas systems within the building and to a point indicated.

#### C. SEQUENCING AND SCHEDULING

1. Notify each affected user when gas supply will be turned off.
2. Work Interruptions: Leave gas systems in a safe condition when interruptions in work occur while repairs or alterations are being made to existing gas piping systems.

### PART II - PRODUCTS

#### A. MANUFACTURERS

1. Acceptable Manufacturers:
  - a. Gas Pressure Regulators:
    - (1) American Meter Co.
    - (2) Fisher Controls.
    - (3) Lancaster by National Meter Parts, Inc.
    - (4) Maxitrol Co.
    - (5) Schlumberger Industries, Gas Div.

#### B. LP GAS PIPING, ABOVE GRADE

1. Steel Pipe: ASTM A53 or A120, Schedule 40 black. Fittings: ANSI/ASME B16.3, malleable iron, or ASTM A234, forged steel welding type. Joints: Screwed for pipe two inches and under; ANSI/AWS D1.1, welded, for pipe over two inches.

#### C. LP GAS PIPING, BURIED

1. Steel Pipe: ASTM A53 or A120, Schedule 40 black. Fittings: ASTM A234, forged steel welding type, with ANSI/AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape. Joints: ANSI/AWS D1.1, welded.

#### D. FLANGES, UNIONS, AND COUPLINGS

1. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping.

#### E. GAS COCKS

1. ASME B16.33, 150 psi WOG, bronze body, bronze tapered plug, square head, with threaded ends.

#### F. GAS PRESSURE REGULATORS

1. ANSI Z21.18 or ANSI Z21.18a, single stage, steel jacketed, corrosion-resistant pressure regulators. Include atmospheric vent, elevation compensator, with threaded ends for 2 inches and smaller and flanged ends for 2-1/2 inches and larger.

### PART III - EXECUTION

#### A. PREPARATION

1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
2. Remove scale and dirt, on inside and outside, before assembly.

#### B. INSTALLATION

1. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
2. Route piping in orderly manner and maintain gradient.
3. Install piping to conserve building space and not interfere with use of space.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
5. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
6. Excavate in accordance with Sections 15010.
7. Backfill in accordance with Sections 15010.
8. Install drips at points where condensate may collect. Locate where readily accessible to permit cleaning and emptying.
9. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 8 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
10. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.
11. Connect branch piping from top or side of horizontal piping.
12. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing elbow fittings with corrosion-resistant insect screens in large end.

C. CONNECTIONS

1. Install gas piping next to gas-utilizing equipment and appliances to allow servicing and maintenance.
2. Connect gas piping to gas-utilizing equipment and appliances with shutoff valves and unions.
3. Install tee fittings forming drips, as close as practical to gas appliance inlets.

D. FIELD QUALITY CONTROL

1. Inspect, test, and purge natural gas systems according to NFPA 54, Part 4 "Gas Piping Inspection, Testing, and Purging" and North Carolina State Gas Code.
2. Repair leaks and defects with new materials, and retest system until satisfactory results are obtained.

E. SERVICE CONNECTION

1. Extend LP gas piping and connect to LP gas tank in location and size indicated.

END OF SECTION 15511

## SECTION 15610 - FURNACES

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes furnaces and accessories listed below, complete with controls.
  - a. Gas-Fired Furnaces.
  - b. Cooling Coils for Furnaces.
  - c. Condensing units.
  - d. Filters.
  - e. Controls.

#### C. DEFINITIONS

1. AFUE: Minimum annual fuel utilization efficiency certified by an independent testing agency in accordance with US Department of Energy Test Procedures.
2. Control Wiring: Wire, conduit, and miscellaneous materials for mounting and connecting electric control devices.
3. Furnace: A self-contained, indirect-fired or electrically heated appliance, with or without cooling coils, that supplies conditioned air through ducts to spaces that require it.

#### D. SUBMITTALS

1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
2. Product data including weights and dimensions and data on features and components. Include plan and elevation views of units, minimum clearances, and data on ratings and capacities.
3. Maintenance data for products for inclusion in "Operating and Maintenance Manual" specified in Division 1.
4. Wiring diagrams from manufacturers detailing electrical requirements for power and control wiring for furnaces. Include ladder-type wiring diagrams for interlock and control wiring required for field installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

#### E. WARRANTY

1. Provide five-year warranty.
2. Warranty: Include coverage for refrigerant compressors.

## PART II - PRODUCTS

### A. MANUFACTURERS

1. Acceptable Manufacturers:
  - a. Gas Furnaces and Condensing Units:
    - (1) Carrier Corp.
    - (2) The Trane Co.; Div. American Standard, Inc.
    - (3) York; Div. York International

## PART III - EXECUTION

### A. EXAMINATION

1. Verify that floors are ready for installation of units and openings are as indicated on shop drawings. Verify that supports for air cooled condensers are completed.
2. Verify that proper power supply is available for furnace and condenser package.
3. Verify that proper fuel supply is available for connection.

### B. INSTALLATION

1. Install in accordance with manufacturer's instructions.
2. Install to NFPA 90A and ANSI/NFPA 90B.
3. Install gas fired furnaces to ANSI Z223.1 (NFPA 54).
4. Provide vent connections to ANSI/NFPA 211.
5. Install refrigerant piping in accordance with ASHRAE Standard 15.
6. Mount air cooled condenser-compressor package on concrete pad.

END OF SECTION 15610

## SECTION 15891 - METAL DUCTWORK

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage.

### PART II - PRODUCTS

#### A. MATERIALS

1. Steel Ducts: ASTM A525 or ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of G-90 for each side in conformance with ASTM A90.
2. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.
3. Fasteners: Rivets, bolts, or sheet metal screws.
4. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
5. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

#### B. LOW PRESSURE DUCTWORK

1. Fabricate and support in accordance with SMACNA Low Pressure Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
2. No variation of duct configuration or sizes permitted except by written permission.
3. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide turning vanes.
4. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
5. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.

6. Connect flexible ducts to metal ducts with liquid adhesive plus tape.
7. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
8. Use double nuts and lock washers on threaded rod supports.

### PART III - EXECUTION

#### A. INSTALLATION

1. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
2. Connect diffusers or troffer boots to low pressure ducts with 5 feet maximum length of flexible duct. Hold in place with strap or clamp.
3. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

#### B. DUCTWORK APPLICATION SCHEDULE

1.	AIR SYSTEM	MATERIAL
	Low Pressure Supply	Steel
	Return and Relief	Steel
	General Exhaust	Steel

#### C. ADJUSTING AND CLEANING

1. Clean duct system and force air at high velocity through duct to remove 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.
2. 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.

END OF SECTION

## SECTION 15910 - DUCT ACCESSORIES

### PART I - GENERAL

#### A. RELATED DOCUMENTS

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

#### B. SUMMARY

1. This Section includes the following:
  - a. Turning vanes.
  - b. Duct-mounted access doors and panels.
  - c. Flexible connectors.
  - d. Flexible ducts

### PART II - PRODUCTS

#### A. VOLUME CONTROL DAMPERS.

1. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
2. Fabricate splitter dampers of material same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
3. Fabricate splitter dampers of double thickness sheet metal to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/4 inch diameter rod in self aligning, universal joint action flanged bushing with set screw.
4. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inch.
5. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
6. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
7. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.
8. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

#### B. AIR TURNING DEVICES

1. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.

C. FLEXIBLE DUCT CONNECTIONS

1. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
2. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per sq yd, approximately 6 inches wide, crimped into metal edging strip.
3. Leaded vinyl sheet, minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

D. DUCT ACCESS DOORS

1. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards and as indicated.
2. Review locations prior to fabrication.
3. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
4. Access doors smaller than 12 inches square may be secured with sash locks.
5. 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 x 48 inches. Provide an additional hinge for larger sizes.
6. Access doors with sheet metal screw fasteners are not acceptable.

PART III - EXECUTION

A. INSTALLATION

1. Install accessories in accordance with manufacturer's instructions.
2. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers only where indicated.
3. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
4. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated.
5. Provide duct test holes where indicated and required for testing and balancing purposes.

END OF SECTION

## **SECTION 15932 - AIR OUTLETS AND INLETS**

### **PART I - GENERAL**

#### **A. RELATED DOCUMENTS:**

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

#### **B. DESCRIPTION OF WORK:**

1. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.
2. Types of outlets and inlets required for project include the following:
  - a. Ceiling air diffusers.
  - b. Wall registers and grilles.

#### **C. SUBMITTALS:**

1. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
  - a. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
  - b. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
  - c. Performance data for each type of air outlet and inlet furnished, throw and drop; and noise criteria ratings. Indicate selections on data.
2. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

### **PART II - PRODUCTS**

#### **A. Manufacturers**

1. Acceptable Manufacturers (Diffusers & Grilles):
  - a. Titus, Inc.
  - b. Metalaire, Inc.
  - c. Carnes, Inc.
  - d. E. H. Price

#### **B. RECTANGULAR CEILING DIFFUSERS**

1. Rectangular, aluminum, multicore type diffuser to discharge air in 360 degree pattern. Louver blades shall have crisp, mitered corners
2. Provide inverted T-bar type frame. In plaster ceilings, provide plaster frame and ceiling frame.

3. Fabricate of aluminum with baked enamel off-white finish.
4. Provide opposed blade damper with damper adjustable from diffuser face.

C. CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

1. Fixed grilles of 1/2 x 1/2 x 1 inch egg crate.
2. Provide inverted T-bar type frame. In plaster ceilings, provide plaster frame and ceiling frame.
3. Fabricate of aluminum with baked enamel off-white finish.
4. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

D. ROOF HOODS

1. Fabricate air inlet or exhaust hoods in accordance with SMACNA Low Pressure Duct Construction Standards.
2. Fabricate of aluminum, minimum 16 gage base and 18 gage hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh and factory prime coat baked enamel finish.
3. Mount unit on minimum 12 inch high curb base with insulation between duct and curb.
4. Make hood outlet area minimum of twice throat area.

PART III - EXECUTION

A. INSTALLATION

1. Install items in accordance with manufacturers' instructions.
2. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
3. Install diffusers to ductwork with air tight connection.
4. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.
5. Paint ductwork visible behind air outlets and inlets matte black.

END OF SECTION 15932

## **SECTION 15990 - TESTING, ADJUSTING, AND BALANCING**

### **PART I - GENERAL**

#### **A. RELATED DOCUMENTS:**

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

#### **B. SUMMARY:**

1. This Section specifies the requirements and procedures total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

#### **C. SECTION INCLUDES**

1. Testing, adjustment, and balancing of air systems.
2. Testing, adjustment, and balancing of hydronic [steam] [and] [refrigerating] systems.
3. Measurement of final operating condition of HVAC systems.

#### **D. SUBMITTALS**

1. Submit under provisions of Section 15500.
2. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
3. Field Reports: Submit under provisions of Section 15500.
4. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
5. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
6. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Owner and for inclusion in operating and maintenance manuals.
7. 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. Report shall reference the contract drawings for location of equipment and devices. Where reference to the contract drawings is not satisfactory, include a set of reduced drawings or sketches with equipment and devices identified to correspond with data sheets.
8. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

9. Test Reports: Indicate data on AABC National Standards for Total System Balance forms or NEBB forms.

E. QUALITY ASSURANCE

1. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, and NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
2. Maintain one copy of each document on site.

F. SEQUENCING AND SCHEDULING

1. Sequence work under the provisions of Section 15500.
2. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.
3. Schedule work under the provisions of Section 15500.

PART II - PRODUCTS (Not Used)

PART III - EXECUTION

A. EXAMINATION

1. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  - a. Systems are started and operating in a safe and normal condition.
  - b. Control systems are installed complete and operable.
  - c. Proper thermal overload protection is in place for electrical equipment.
  - d. Ductwork Systems:
    - (1) Final filters are clean and in place. If required, install temporary media in addition to final filters.
    - (2) Duct systems are clean of debris.
    - (3) Fans are rotating correctly.
    - (4) Dampers are in place and open.
    - (5) Air coil fins are cleaned and combed.
    - (6) Access doors are closed and duct end caps are in place.
    - (7) Air inlets and outlets are installed and connected.
    - (8) Duct system leakage is minimized.
2. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
3. Beginning of work means acceptance of existing conditions.

B. PREPARATION

1. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Owner to facilitate spot checks during testing.

2. Provide additional balancing devices as required.

C. INSTALLATION TOLERANCES

1. HVAC Systems: Adjust to within plus or minus 5 percent of design for supply and return systems and plus or minus 10 percent of design for exhaust systems.
2. Air Outlets and Inlets: Adjust outlets and inlets in space to within plus or minus 10 percent of design.

D. ADJUSTING

1. Ensure recorded data represents actual measured or observed conditions.
2. Permanently mark settings of balancing devices allowing settings to be restored. Set and lock memory stops.
3. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
4. 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. AIR SYSTEM PROCEDURE

1. Adjust equipment and distribution systems to provide required or design air quantities.
2. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
3. Measure and record air quantities at air inlets and outlets.
4. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
5. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Adjust air volume by adjusting duct internal devices such as dampers and splitters. Do not utilize opposed blade dampers at air inlets and outlets.
6. Vary total system air quantities by adjusting sheave position at each fan. Vary branch air quantities by damper regulation.
7. Measure and record static air pressure conditions at air supply and exhaust units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
8. Measure and record temperature conditions across dampers to check leakage.
9. Where modulating dampers are provided, take measurements and balance at extreme conditions.

10. Measure and record building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.
11. Measure and record inlet and outlet temperatures at each air supply unit at full cooling and heating capacity.

F. REPORT FORMS

1. Forms shall include the following:
  - a. Title Page:
    - (1) Name of Testing, Adjusting, and Balancing Agency.
    - (2) Address of Testing, Adjusting, and Balancing Agency.
    - (3) Telephone number of Testing, Adjusting, and Balancing Agency.
    - (4) Project name.
    - (5) Project location.
    - (6) Project Architect.
    - (7) Project Engineer.
    - (8) Project Contractor.
    - (9) Project altitude.
    - (10) Report date.
  - b. Summary Comments:
    - (1) Design versus final performance.
    - (2) Notable characteristics of system.
    - (3) Description of systems operation sequence.
    - (4) Summary of outdoor and exhaust flows to indicate amount of building pressurization.
    - (5) Nomenclature used throughout report.
    - (6) Test conditions.
  - c. Instrument List:
    - (1) Instrument.
    - (2) Manufacturer.
    - (3) Model number.
    - (4) Serial number.
    - (5) Range.
    - (6) Calibration date.
  - d. Electric Motors:
    - (1) Manufacturer.
    - (2) Model/Frame.
    - (3) HP/BHP/efficiency.
    - (4) Phase, voltage, amperage; nameplate, actual, no load.
    - (5) RPM.
    - (6) Service factor.
    - (7) Starter size, rating, heater elements.
    - (8) Sheave Make/Size/Bore.
  - e. Equipment Data:
    - (1) Identification/number.
    - (2) Manufacturer.
    - (3) Model number and Serial number.
    - (4) Capacity.
    - (5) Service.
    - (6) Design flow rate, pressure drop, BHP.

- (7) Actual flow rate, pressure drop, BHP.
- (8) Temperature readings.
- f. Duct Traverse:
  - (1) System zone/branch.
  - (2) Duct size.
  - (3) Area.
  - (4) Design velocity.
  - (5) Design air flow.
  - (6) Test velocity.
  - (7) Test air flow.
  - (8) Duct static pressure.
  - (9) Air temperature.
  - (10) Air correction factor.
- g. Air Distribution Test Sheet:
  - (1) Air terminal number.
  - (2) Room number/location.
  - (3) Terminal type.
  - (4) Terminal size.
  - (5) Area factor.
  - (6) Design velocity.
  - (7) Design air flow.
  - (8) Test (final) velocity.
  - (9) Test (final) air flow.
  - (10) Percent of design air flow.

END OF SECTION