

SECTION 15010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section.
 - 1. General Mechanical Provisions
 - 2. Codes, ordinances, permits, fees, or assessments
 - 3. Submittals
 - 4. Record Documents
 - 5. Maintenance Manuals
 - 6. Delivery, storage, and handling
 - 7. Rough-ins
 - 8. Cutting and Patching
 - 9. Substitutions

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, apply to this and the other sections of Division 15. Each Division 15 Section applies where applicable to all other Division 15 Sections.

1.3 GENERAL MECHANICAL PROVISIONS

- A. The work in this Division consists of furnishing all labor and materials, accessories, equipment, transportation, supervision, start-up services, instructions, permits and incidentals, and related items necessary to complete installation and successfully test, start-up and operate, in a practical and efficient manner, all mechanical work and systems indicated on the drawings and described in each Section of this Division. The work shall also include any items which, while not specifically included in these specifications or drawings, are reasonable and properly inferable therefrom or are accepted trade practice or necessary for the proper completion of this System.
- B. The General Requirements of these specifications govern all portions of this heating, ventilating and plumbing system and will apply in full force to this contract. These Contractors shall, therefore, consider them as forming an integral part of this contract.
- C. Submission of a Bid Proposal is considered evidence that a contractor has visited the site, examined the drawings and specifications of all Trades and has fully informed himself as to project and site conditions and is proficient, experienced and knowledgeable of all state, local and federal standards, codes, ordinances, permits and regulations which affect every subcontractor trade's completion, cost and time required and that all costs are included in his Bid Proposal.
- D. The Contractor shall be responsible for all Subcontractors and suppliers, and shall include in his Bid Proposal and properly apportion, all materials, labor and equipment to the Subtrades.
- E. All labor, materials and equipment shall be guaranteed by the Contractor and/or warranted by the manufacturer for one calendar year after date of final acceptance, except where specific, longer periods

are specified. Make all necessary alterations, repairs, adjustments and replacements during guarantee period as directed by Engineer to comply with drawings and specifications. Such work shall be at no cost to the Owner.

- F. Provide the service of factory-trained personnel for such periods of time as required to instruct the Owner's personnel on operation and maintenance of installed equipment.
- G. This Contractor shall have in charge of the work at all times during construction a thoroughly competent Field Superintendent with experience in the work to be installed under this contract.
- H. Where a conflict exists between the drawings and specifications it shall be immediately brought to the engineers attention. If such a conflict is not resolved before work commences, contractor shall provide the most work of greatest value.
- I. All products shall be installed per the manufacturers written instructions. Where a conflict exists between the contract documents and the manufacturers instructions, the engineer shall be notified immediately to resolve the conflict.

1.4 CODES, ORDINANCES, PERMITS, FEES OR ASSESSMENTS

- A. All work and materials shall be installed in accordance with the standards as described by local and state codes or ordinances including the rules of the National Plumbing Code, National Board of Fire Underwriters, American Standards Association, and with the prevailing rules and regulations pertaining to adequate protection and guarding of any moving parts or otherwise hazardous locations.
- B. Should the drawings or specifications call for sizes and grades different than required by the governing code, this Contractor shall furnish and install the larger size of the higher grade.
- C. In addition, this Contractor shall give all notices, file all drawings, obtain all necessary approvals, obtain all permits, pay for all fees, deposits and expenses required for installation of all work under this contract, as stated therein and in the General Requirements. In such instances where permits are not required, the contractor shall engage a third party, preferably the local official, to inspect the work.
- D. In addition to all applicable federal, state and local codes, the standards and codes listed below shall apply to all mechanical work. Where standards or codes are mentioned in these specifications, the latest edition or revision shall be followed; hence, the specified numbers may be superseded by new numbers.
 - 1. American National Standard Institute (ANSI)
 - 2. American Society for Testing Materials (ASTM)
 - 3. American Society of Mechanical Engineers (ASME)
 - 4. American Water Works Association (AWWA)
 - 5. Air Moving and Condition Association, Inc. (AMCA)
 - 6. Air Diffusion Council (ADC)
 - 7. American Society Heating, Ventilating and Refrigerating and Air Conditioning Engineers (ASHRAE)
 - 8. National Electrical Manufacturer's Association (NEMA)
 - 9. American Refrigeration Institute (ARI)
 - 10. ANSI Code of Pressure Piping and Unfired Pressure Vessels
 - 11. Cast Iron Soil Pipe Institute
 - 12. Underwriter's Laboratories (U.L.)

13. National Fire Protection Association (NFPA)
14. American Gas Association (AGA)
15. Occupational Safety and Health Acts (OSHA)
16. Sheet Metal and Air Conditioning National Association (SMACNA)
17. S.B.C.C.I. 1997 Codes
18. 2000 Michigan Mechanical Code

1.5 SUBMITTALS

A. General

1. Submit 6 copies for each required submittal. Submittals to include the following;
 - a. Product manufacturer's name.
 - b. Performance data.
 - c. Dimensional data
 - d. Electrical requirements.
 - e. Applicable testing agency labels and seals.

1.6 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section, Project Closeout. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 15 Section, Mechanical Identification. Indicate actual inverts and horizontal locations of underground piping.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Contract Modifications, actual equipment and materials installed.

1.7 MAINTENANCE MANUALS

A. Prepare maintenance manuals, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.8 SUBSTITUTIONS

- A. This Contractor shall be considered liable for all added costs both to himself and others (including those costs as incurred by the Engineer, for redesigning or redrawing) resultant from the substitution of products not the basis of the design.
- B. This Contractor shall be responsible for the verification of adequate space (considering dimensions, required clearances, weights, and roughing-in requirements) for the installation of items or systems not the basis of the design. He shall be responsible for advising all other trades. He shall submit revised drawing layouts for the approval of the Engineer and shall not proceed without this approval.

PART 2 - EXECUTION

2.1 CUTTING AND PATCHING

- A. Perform cutting and patching, the following requirements apply:
 - 1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting and patching of mechanical equipment and materials required to:
 - 1. Uncover work to provide for installation of ill-time work.
 - 2. Remove and replace defective work.
 - 3. Remove and replace work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed work as specified for testing.
 - 5. Install equipment and materials in existing structures.
 - 6. Cut, channel, chase and drill floors, wells, partitions, ceilings and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
 - 7. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.
- C. Cut, remove and turnover the selected mechanical equipment, components and materials as indicated, including but not limited to removal of mechanical piping, heating units, and control devices, and other mechanical items made obsolete by the new work.
- D. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- F. Patch existing finished surfaces and building components using new materials matching existing materials and utilizing experienced installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

END OF SECTION 15010

SECTION 15050

MATERIALS AND METHODS

PART 1 GENERAL

1.1 OPERATION PRIOR TO ACCEPTANCE

- A. When any equipment is operable, and it is to the advantage of the Contractor to operate the equipment, he may do so provided that he properly supervises the operation, and retains full responsibility for the equipment operated. Before final acceptance by the owner, the Contractor shall properly clean the equipment, install clean filter media, make all required adjustments and complete all punch list items.

1.2 WARRANTY

- A. Warrant to Owner that materials, equipment, and workmanship provided under this Division of the Specifications will be free from defects for a period of one year from the date of acceptance by Owner. Additional equipment warranty requirements are stated in other sections of the specifications.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Products are to be new and free from defects, and are to be installed by competent specialist for each trade in accordance with the manufacturer's recommendations. Materials or equipment not meeting these standards, or the acceptance of the Engineer, may be rejected and will be replaced at no additional costs to the owner.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

- A. Conceal piping in pipe chases, walls, furred spaces and above ceiling, unless otherwise indicated.
- B. Should any condition arise which would cause piping or ductwork to be exposed in finished areas, it will be called to the architect/owner's attention immediately and corrected in accordance with the architect/owner's instructions.

3.2 HANGERS AND SUPPORTS

- A. Provide and install per ANSI Standards SP-58 and SP-69.
- B. Adequately support pipes throughout the buildings, both horizontal and vertical.

- C. Hanger Schedule
- | PIPE SERVICE | HANGER SIZE | TYPE | GRINNELL NO. |
|---------------------|--------------|------------|-----------------|
| Uninsulated Steel | 2" & smaller | Split Ring | 108 with 114 |
| Uninsulated Copper | 2" & smaller | Ring | CT 99 |
| Cast Iron Soil Pipe | All | Clevis | 590 |
| Insulated Steel | 4" & smaller | Clevis | 260 with shield |
| Insulated Copper | 2" & smaller | Clevis | CT 65 |
- D. Multiple or Trapeze Hangers” Steel channels with angles or unistrut spacers and hanger rods.
- E. Wall Support 2 1/2 inch and over: Welded steel bracket and wrought steel clamp.
- F. Vertical Support: Steel riser clamp.
- G. Provide copper plated hangers and supports for copper piping or provide sheet plastic tape wrapping between hanger or support and piping.
- H. Equivalent products of Fee and Mason or Elcen are acceptable substitutes for the Grinnell hangers specified.
- I. Maximum horizontal pipe hanger support spacing and minimum rod diameter for rigid rod hangers (see chart).
- J. Install hangers to provide minimum 1/2-inch clear space between finished covering and adjacent work.
- K. Place a hanger within one foot of each horizontal elbow.
- L. Support horizontal soil pipe near each hub, with 10 feet maximum spacing between hangers.
- M. Support PVC piping per manufacturer's recommendations.

3.3 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

- A. Follow manufacturer's published directions in the delivery, storage, protection, installation, piping and wiring and start-up of equipment and materials.

3.4 ACCESS PANELS AND DOORS

- A. Install access panels and doors for concealed equipment and valves.

3.5 TESTS

- A. Field test mechanical equipment furnished and installed under this Contract as required by the

Engineer Tests.

- B. Perform tests required by governing authorities, in addition to tests specified in individual Sections.
- C. Complete final installation and testing 14 days prior to Contract Substantial Completion Date.
- D. All pipe work shall be tested at the pressure equal to the design working pressure of the pipe for the intended service and maintain this pressure for not less than two hours with not more than 1% drop in pressure.
- E. Notify architect/owner of any test failures. Submit weekly pipe test log listing service; section tested, initial and final pressure, time and temperature.

END OF SECTION

SECTION 15400

PLUMBING SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Water piping.
 - 2. Sanitary drainage.
 - 3. Condensate piping.
 - 4. Testing.
- B. Comply with other Division 15 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SUBMITTALS

- A. Make submittals for all products specified in the specification.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Water Piping Above Grade, Type "L" hard drawn, seamless copper water tube, ASTM B88 and Federal Specification WW-T-799. Joined with wrought copper pressure fittings, ANSI B16.22. Make joints using "lead free" solder and a non-corrosive paste-type flux. Core solder is not allowed. Solder will be solid string or wire type. Where soldered copper piping is connected to threaded brass piping, use a cast brass adaptor.
- B. Water Piping Below Grade, Type "K" hard drawn, seamless copper water tube, ASTM B88 and Federal Specification WW-T-799. Joined with wrought copper pressure fittings, ANSI B16.22. Make joints using "lead free" solder and a non-corrosive paste-type flux. Core solder is not allowed. Solder will be solid string or wire type. Where soldered copper piping is connected to threaded brass piping, use a cast brass adaptor.
- C. Make piping connections to fixtures and equipment with chrome-plated seamless brass tube, ASTM B-125 and Federal Specification WW-T0791. No ferrous piping or materials are allowed in water piping smaller than 4 inches.

2.2 SANITARY DRAINAGE

- A. Sanitary Drainage lines (Soil, Waste and Vent): Cast iron soil pipe and fittings, coating inside and outside, ASTM A74 and Federal Specification WW-P-401. Label with Cast Iron Soil Pipe Institutes' "Mark of Quality and Permanence". Weights of pipe are required by code for location and duty. Joints shall be fabricated by use of "Push-On" type gasketed joints (above or below ground) or "No-Hub" mechanical joints (above ground only). Where permitted by local codes, PVC-DWV Plastic Schedule 40, NSF Seal CS-272 may be used for sanitary drainage pipes (soil, waste, and vent), with solvent-welded joints.

2.3 VALVES

- A. Valves for Domestic Water Piping Systems: Nibco S580 or equal.

2.4 PRESSURE REDUCING VALVE

- A. When the water system static pressure is greater than 75 PSI, furnish and install a pressure-reducing valve ahead of all fixtures and located in an accessible place. Set pressure at 50 PSI downstream of backflow preventer. Contractor to verify supply pressure.

2.5 COMMERCIAL TYPE WATER HAMMER ARRESTERS

- A. Provide commercial type water hammer arrester on hot and cold water supplies as generally indicated, with precise location and sizing to be in accordance with PD1-WH201.
- B. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels.
- C. Water hammer arresters shall be in accordance with PD1-WH201, as furnished by Watt, Josam or equal.
- D. Vertical capped pipe columns will not be permitted.

2.6 BACKFLOW PREVENTER

- A. Provide a Watts #909 reduced pressure backflow preventer for the domestic water service.

2.6 PLUMBING FIXTURES

- A. Provide and install fixtures as shown on plans.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

- A. Install piping neatly and parallel with or perpendicular to lines of the structure. Install pipe hangers to maintain accurately aligned piping systems, adequately supported both laterally and vertically. Install horizontal soil, waste, and vent pipe with a grade of 1/4" per foot where possible and not less than 1/8" per foot. Where practicable, connect two or more vents together and extend as one vent through roof. Make vent connections to stacks by appropriate use of 45 wyes, long sweep quarter bends, sixth, eighth or sixteenth bends, except that sanitary tees may be used on the vertical stacks.
- B. Extend condensate drain piping from units with condensate discharge.
- C. Install drains at all low points and vents at high points in water distribution system.

3.2 PIPING

- A. Refer to Section 15700 for insulation requirements.

3.3 PIPE TESTS

- A. Test water piping before installing equipment and before insulation is applied, using specified methods and conditions. Subject piping to test for not less than 24 hours under inspection by the Engineer. Make necessary replacements and repairs and repeat tests until entire system is accepted as satisfactory. Work includes testing equipment. After installation of equipment, operate systems; clean out scale, dirt, oil, waste and foreign matter, and correct additional leaks. Test underground piping prior to backfilling.

- B. Test plumbing drainage systems under 10 foot static head. Test water systems under 150 PSIG hydrostatic pressure.
- C. Flush system thoroughly of dirt and foreign matter, then fill with water treated with 50 ppm of chlorine. During filling process, open valves and faucets several times to assure treatment of entire system. Leave treated water in system for 24 hours after which time system may be flushed; if residual chlorine is not less than 10 ppm, repeat flushing. After sterilization, receive approval by regulatory agency on samples of water in system.

END OF SECTION

SECTION 15700

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Work included:
 - 1. The work covered by this section of the specifications consists of furnishing all labor, materials, equipment and accessories necessary for the insulation for piping and air duct system. Insulation on new system connected to or modified are included. All insulation work is to be in strict accordance with this specification, applicable drawings and subject to the terms and conditions of the contract. Finishes of new insulation on existing systems shall match the adjacent finish.
 - 2. Domestic water piping.

1.2 RELATED DOCUMENT

- A. Drawings and general provisions of contract, including general and special conditions, apply to work specified in this section.

1.3 SUBMITTAL DATA

- A. Submittal data for insulating work shall contain a comprehensive summary or listing of all surfaces and systems to be insulated with each item defining type of surface covering vapor barriers, joining methods, fitting insulation, finishes, clips and pipe protection devices. Also included with submittal shall be manufacturers' complete engineering data on each item or material to be used with recommended installation method for each.

1.4 FIRE SAFETY STANDARDS

- A. All insulation shall have composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure ASTM E-84, NFPA 255 and UL 723 not exceeding:
 - 1. Flame Spread 25
 - 2. Smoke Developed 50
- B. Accessories, such as adhesives, mastics, cements, tapes and cloths for fittings shall have the same component ratings as listed above. All products or their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed above requirements. Any treatment of jackets or facings to impart flame and smoke safety shall be permanent. The use of water-soluble treatment is prohibited. The insulation contractor shall certify that all products used have met the above criteria.

1.5 THERMAL CONDUCTIVITY

- A. Indicated insulation thickness is based on an average thermal conductivity not to exceed .28 BTU per inch thickness per square foot, per degree F. per hour at a mean temperature of 75 degrees.

1.6 FITTINGS, VAPOR SEALS AND ACCESSORIES

- A. Insulation on all cold surfaces where vapor barrier jackets are used, shall be applied with a continuous unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation. Vapor barrier shall be sealed at ends of insulation and cutoff seals shall be provided at approximately 20 feet

- intervals in the piping.
- B. At all hanger support locations in piping system, install pipe protection thermal hanger shields of waterproofed calcium silicate insulation, the same thickness as the adjacent pipe insulation, cased 360 degrees by galvanized steel. Shields shall be a standard product of the manufacturer and shall be as manufactured by Pipe Shield, Inc. or equal.
 - C. A general purpose vapor barrier jacket shall be used on all piping. Jacket shall consist of glass fiber reinforced heavy Kraft paper laminated to aluminum foil.
 - D. All fittings shall be insulated with fiberglass and vinyl fitting covers. The insulation shall be to a thickness equal to the adjacent pipe insulation on exposed piping. Fitting insulation shall be vapor proofed on chilled piping.
 - E. Adhesives, mastics and coating shall be Benjamin Foster of products of equal quality and performance as made by Chicago Mastic Company.

PART 2 PRODUCTS

2.1 INSULATION

- A. Domestic Water Piping (Hot and Cold)
 - 1. Hot and cold domestic water piping shall be insulated with 1" thick (for hot water) and 1/2" thick (for cold water) fiberglass similar to Owner Corning type 25 SFG with vapor barrier jacket where exposed and in plenum.

2.2 ACCEPTABLE MANUFACTURERS

- A. Insulation products meeting requirements described, as manufactured by Johns-Manville, Owens-Corning, CSG, Armstrong, BEH, Knauf or Pittsburgh will be acceptable.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Pipe Application
 - 1. All insulation shall be installed in a workmanlike manner by skilled workmen regularly engaged in this type of work. The insulation shall be applied over clean dry pipe with all joints butted firmly together.
 - 2. All insulation shall be continuous through wall and ceiling openings and sleeves.
 - 3. Insulation shall not be installed on any pipe surfaces until those surfaces have been inspected and released for insulation application.

END OF SECTION

SECTION 15990

TESTING AND BALANCING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. This section specifies the requirements and procedures for total mechanical systems testing, adjusting and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical system as required to meet design specifications, recording and reporting the results and operation of all systems to demonstrate satisfactory performance to the Owner.
- B. Test, adjust and balance the following mechanical systems:
 - 1. Supply, return and exhaust air systems
 - 2. Hydronic heating and cooling systems.
 - 3. Verify temperature control system operation.
- C. This Section does not include:
 - 1. Specifications for materials for patching mechanical systems.
 - 2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
 - 3. Requirements and procedures for piping and ductwork systems leakage tests.

1.2 DEFINITIONS

- A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
 - 1. The balance of air and water distribution
 - 2. Adjustment of total system to provide design quantities
 - 3. Electrical measurement
 - 4. Verification of performance of all equipment and automatic controls
 - 5. Sound and vibration measurement
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g. reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (sub mains, branches and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results
- F. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data sheets should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. There are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminal such as registers, grilles, diffusers, louvers and hoods.
- H. Main: Duct or pipe containing the system's major or entire fluid flow.
- I. Submain: Duct or pipe containing part of the system's capacity and serving two or more branch mains.
- J. Branch Main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

1.3 SUBMITTALS

A. Agency Data:

1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below. The firm or individuals performing the work herein specified may be the installing firm or individuals or may be separate and independent firm or individuals employed by the contractor but in either case the personnel performing the work shall be qualified and certified as specified.

B. Engineer and Technicians Data:

1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below. The firm or individuals performing the work herein specified may be the installing firm or individuals or may be a separate and independent firm or individuals employed by the Contractor, but in either case the personnel performing the work shall be qualified and certified as specified.

C. Procedures and Agenda: Submit a synopsis of the testing adjusting and balancing procedures and agenda proposed to be used for this project.

D. Maintenance Data: Submit maintenance and operating data that includes how to test, adjust and balance the building system. Include this information in maintenance data specified in Division 15 - Basic Mechanical Requirements.

E. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

F. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and form as specified below:

G. Reports: Upon completion of testing, adjusting, and balancing procedures, prepare reports on the approved forms. Reports may be hand written, but must be complete, factual, accurate and legible. Submit 3 complete sets of reports. Only 2 complete sets of draft reports will be returned.

H. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs.

1. General Information and Summary
2. Air Systems
3. Temperature Control Systems

I. Report Contents: Provide the following minimum information, forms and data:

1. General Information and Summary: Inside cover sheet to identify testing, adjusting and balancing agency, contractor, Owner, Architect, Engineer and Project. Include addresses, and contact names a telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the proof of calibration.
2. The remainder of the report shall contain appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system to accompany each respective report form. The report shall contain the following information, and all other data resulting from the testing, adjusting and balancing work:
3. All nameplate and specification data for all pumps, air handling equipment and motors.
4. Inlet water and outlet water temperatures of each heating and cooling element.

5. Water pressure drop through each heating and cooling coil.
6. Operating suction and discharge pressure and final total discharge head for each pump.
7. Water flow readings at all pumps and coils.
8. Actual metered running amperage for each phase of each motor on all pumps and air handling equipment.
9. Actual metered voltage at each pump and each piece of air handling equipment (phase to phase for all phases)
10. Static pressure for each piece of air handling equipment and at each location in ductwork system where static pressure controllers are located.
11. Fan RPM for each piece of air handling equipment.
12. Total actual DCM being handled by each piece of air handling equipment.
13. Entering and leaving air temperature of all air handling unit heating coils and cooling coils.
14. Actual CFM of systems by rooms.

1.4 CERTIFICATION

- A. Agency Qualifications:
 1. Employ the services of a certified testing, adjusting and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust and balance the building mechanical systems, identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, recording and reporting the results and operation of all systems to demonstrate satisfactory performance to the Owner.
 2. The testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project and having at least one person certified by NEBB or AABC as a Test and Balance Engineer.
- B. Codes and Standards
 1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems". Or
 2. AABC: "National Standards for Total System Balance", And
 3. ASHRAE: "ASHRAE Handbook", 1984 Systems Volume, Chapter 37, Testing, Adjusting and Balancing.
- C. Pre-balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect/Engineer and representatives of installers of the mechanical system. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

1.5 PROJECT CONDITIONS

- A. Systems Operation: System shall be fully operational and clean prior to beginning procedures.

1.6 SEQUENCING AND SCHEDULING

- A. Test, adjust and balance the air systems before Hydronic, steam and refrigerant systems.
- B. Test, adjust, and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg. F. Wet bulb temperature of maximum summer design condition and within 10 deg. F. Dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.1 PRELIMINARY PROCEDURE FOR AIR SYSTEM BALANCING

- A. Before operating the system, perform these steps:
 1. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.

2. Check filters for cleanliness and to determine if they are the type specified.
3. Check dampers (both volume and fire) for correct and locked position. Check automatic operating and safety controls and devices to determine that they are properly connected, functioning and at proper operating set point.
4. Check automatic control dampers to determine that they are functioning properly, that they will close tightly and those they will open and close smoothly without binding or backlash.
5. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross check with required fan volumes.
6. Determine best locations in main and branch ductwork for most accurate duct traverses.
7. Place outlet dampers in the full open position.
8. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
9. Lubricate all motors and bearings.
10. Check fan belt tension.
11. Check fan rotation.

3.2 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments that have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivision and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings that will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all readings with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuating readings.
- I. Take measurements in the system where best suited to the task.

3.3 PERFORMANCE TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards. Balancing of the air systems and hydronic systems shall be achieved by adjusting the automatic controls, balancing valves, dampers, air terminal devices and the fan/motor drives within each system.
- B. Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork and hosing, using materials identical to those removed.
- D. Seal ducts and piping, and test for and repair leaks.
- E. Seal insulation to re-establish integrity of the vapor barrier.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- G. Retest, adjust and balance systems subsequent to significant system modifications and resubmit test results.

3.4 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

3.5 DEMONSTRATION

- A. Training:
 - 1. Train the Owner's maintenance personnel on trouble shooting procedures and testing, adjusting and balancing procedures. Review with the Owner's personnel, the information contained in the Operating and Maintenance Data specified in Division 15.
 - 2. Schedule training with Owner through Engineer with at least 7 days prior notice.

END OF SECTION