

SECTION 15000 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions, Supplementary General Conditions, and Special Conditions of this Contract form a part of this Division of Specification.
- B. This section forms a part of all sections under Division 15 Mechanical.
- C. Requirements herein augment or clarify articles specified under aforementioned General and Special Conditions.

1.2 SITE EXAMINATION

- A. Before submitting bid, Contractor shall examine the premises and satisfy himself as to the existing conditions under which he will be obliged to operate or what will affect the work under this Contract. Contractor shall report to the Architect any condition which might prevent installation of equipment or systems in the manner intended. No allowance will be made subsequently in this connection in behalf of this Contractor for error or negligence on his part.

1.3 CODES AND STANDARDS

- A. Latest effective publications of applicable codes and ordinances of local governing agencies and of the following standards, codes, etc., as they apply, form part of these specifications as if were written fully herein. The publication date is the publication in effect as of the bid date, except when a specific publication date is listed. These will be referred to throughout in abbreviated form.
 - 1. North Carolina State Building Code (2009)
 - 2. National Fire Protection Association (NFPA)
 - 3. Factory Mutual Engineering Association (FM)
 - 4. Underwriters' Laboratories, Inc. (UL)
 - 5. Occupational Safety and Health Administration (OSHA)
 - 6. American Society of Mechanical Engineers (ASME)

7. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
8. Air Conditioning and Refrigeration Institute (ARI)
9. American National Standards Institute (ANSI)
10. American Society for Testing and Materials (ASTM)
11. American Welding Society (AWS)
12. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
13. Air Movement and Control Association, Inc. (AMCA)
14. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA)
15. Electrical Testing Laboratories (ETL)
16. Americans with Disabilities Act (ADA)
17. North Carolina State International Mechanical Code (2009)
18. International Plumbing Code
19. North Carolina State Energy Conservation Code (2009)

1.4 PERMITS, INSPECTIONS, FEES AND NOTICES

- A. Unless modified by the General Conditions and Supplementary Conditions, work is to be executed and inspected in accordance with governing codes, laws, ordinances, rules, and regulations applicable to particular class of work, and fees in connection therewith are to be paid by this Contractor.
- B. This Contractor is to arrange for project inspection, paying charges pertaining hereto. He shall give the proper authority requisite notice relating to work under his charge, shall afford Architect and authorized inspectors every facility for inspection and shall be responsible for violations of law. Upon completion of work, he shall have work inspected, if required, obtaining certificate of inspection and approval from inspecting agency, and shall deliver such certificate to Architect.

1.5 SCOPE OF WORK

- A. Work required for Division 15 Mechanical shall include labor, materials, equipment, appurtenances, and services to provide first class working systems, tested and ready for operation. Installation shall conform to the drawings and specifications, incorporating the best standards of workmanship. Materials shall be new and of good quality, and labor shall be performed by skilled mechanics under the direction of a competent superintendent.

1.6 DRAWINGS AND SPECIFICATIONS

- A. The implied and stated intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
- B. Apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or incidental accessories necessary to make the work complete and ready for operation, even if not particularly specified, shall be provided by the Contractor without additional expense to the Owner.
- C. Contractor shall examine and consult drawings and specifications of other trades to better familiarize himself with the character of construction and include in his bid work of his trade shown or reasonably inferred. He shall consult the drawings and specifications of other trades in installing his work.
- D. This Contractor shall be thoroughly familiar with specified products relating to his work and shall submit written objections prior to bid if he objects to the proposed use of any product.
- E. Should structural difficulties prevent the installation of piping, ductwork, fixtures, or equipment at the points shown on the drawings, necessary deviations therefrom, as determined by the Architect, will be permitted and shall be made without additional cost. This Contractor shall work with other Contractors and arrange his work so as not to interfere with the work of other Contractors.
- F. Drawings are diagrammatic, intending to show general arrangement and location of system components, with no attempt made to show every ell, tee, fitting, etc. Due to the small scale of the drawings, and to unforeseen job conditions, required offsets and fittings may not be shown but shall be

provided at no change in Contract price. Ducts and pipes shall be run in spaces indicated as job conditions warrant, arranged for most convenient access for servicing, with due consideration given to swing joints and to other Contractor's work. If departures from the contract drawings are deemed necessary, Contractor shall submit details of such departures and the reasons therefor as soon as practicable after award of contract to the Architect for approval. Make no such departures without prior written approval of the Architect.

- G. Contractor shall maintain on site a current set of drawings and specifications.
- H. In case of conflicting information on the drawings and/or in the specifications, the proper interpretation shall be made by the Architect.
- I. Disagreements occurring between trades covering various phases of the work shall be referred to General Contractor for decision.
- J. Changes and additions to scope of the work under this contract shall be submitted to the Architect and his written approval obtained before proceeding with the changed work.

1.7 WORDING

- A. Specifications are of simplified form and include incomplete sentences. Omission of words or phrases such as "the Contractor shall", "shall be", "provide", "furnish", "a", "an", "the" is intentional. Omitted words or phrases shall be supplied by inference.

1.8 DEFINITIONS

- A. "Provide": To furnish, erect, install, and connect up complete and ready for regular operation, particular work referred to, unless specifically indicated or specified otherwise.
- B. "Work": Labor and materials, or both, including apparatus, controls, accessories, and other items necessary or required to provide a complete installation.
- C. "Piping": Pipe and fittings, flanges, valves, controls, hangers, traps, drains, insulation, and items necessary or required in connection with or relating to such piping to provide a complete installation.

- D. "Concealed": Embedded in masonry or other construction, installed behind wall furring, within double partitions or above hung ceilings, in trenches, tunnels, or crawl spaces.
- E. "Exposed": Not installed underground or "concealed" as defined above.
- F. "Indicated" or "Shown": As indicated or shown on drawings.
- G. "Noted": As indicated on drawings and/or specified.
- H. "Contract" or "this Contract" shall consist of documents listed in the Contractor Agreement and Supplemental Agreements, data or drawings which could reasonably be required to complete the work. This shall be considered as one instrument and referred to collectively as the "Contract Documents".
- I. Whenever the words "as shown" or "indicated" are used in the description of any part of the work, it shall be understood to mean as shown on the contract drawings, unless another meaning is plainly indicated or noted.

1.9 SUBMITTALS

- A. Submit Shop Drawings, Product Data and Samples within thirty (30) days of award of contract and in accordance with the General Conditions and Supplementary Conditions. All interdependent equipment, i.e., chillers, boilers, pumps and associated hydronic equipment, shall be submitted simultaneously. Submittals are required for items provided under this specification. Review of submittals by the Architect and associated action taken by the Architect does not relieve the contractor of requirements set forth by the contract documents.
- B. Submittals shall clearly indicate all features, options, capacities, etc. to show compliance with the drawings and specifications.
- C. The Contractor Shall:
 - 1. Coordinate submittal with requirements of the work and of the Contract Documents.
 - 2. Notify the Architect in writing, at time of submission, of deviations in the submittals from requirements of the Contract Documents.
 - 3. Begin no fabrication or work which requires submittals until return of submittals with Architect approval.

4. Make submittals promptly and in such sequence as to cause no delay in the work or in the work of other contractors.
- D. Drawings prepared by the Contractor, for the Contractor's use, shall be submitted for review. Such drawings include, but are not limited to: equipment layout drawings, coordination drawings, and drawings of miscellaneous details.
- E. Prepare Product Data as Follows:
1. Clearly mark each copy to identify pertinent products or models.
 2. Show performance characteristics and capacities.
 3. Show dimensions and clearances required.
 4. Show wiring diagrams, piping diagrams and controls.
- F. Prepare manufacturer's standard schematic drawings and diagrams as follows:
1. Modify drawings and diagrams to delete information which is not applicable to the work.
 2. Supplement standard information to provide information specifically applicable to the work.
- G. Prepare office samples of sufficient size and quantity to clearly illustrate:
1. Functional characteristics of the product, with integrally related parts and attachment devices.
 2. Full range of color, texture and pattern.
- H. Submittals shall contain:
1. The date of submission and of any previous submissions.
 2. The project title and number.
 3. Contract or project identification.
 4. The names of:

- a. Contractor.
 - b. Supplier.
 - c. Manufacturer.
5. Identification of the product, and specification section.
 6. Field dimensions, clearly identified as such.
 7. Relation to adjacent or critical features or materials.
 8. Applicable standards.
 9. Identification of deviations from Contract Documents.
 10. Identification of non-complying features and reason for the non-compliance. The reason shall be specific in nature.
 11. Identification of revisions on resubmittals.
 12. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.
- I. Submittals of Mechanical and Plumbing Equipment requiring maintenance shall be accompanied by three (3) sets of the manufacturers' standard Operating and Maintenance Instructions and Parts Lists. A bound manual with an index and identification tabs shall be prepared for each set. These are to be retained by Contractor, until completion of job, at which time they will be assembled and turned over to the Architect.

1.10 SUBSTITUTIONS AND PRODUCT OPTIONS

- A. Contractor's Options:
1. For Products specified only by reference standard, select any product meeting that standard.
 2. For products specified by naming several products or manufacturers, select any one of the products or manufacturers named, which complies with the specifications.

3. For products specified by naming one or more products or manufacturers and "or equal", or where a particular product is indicated as the basis of design, Contractor must submit a request prior to bid as for substitutions for any product or manufacturer not specifically named.

B. Substitutions:

1. For a period up to 15 days prior to bid, the Architect will consider written requests from Contractor for substitution of products.
2. Submit a separate request for each product, supported with complete data, with drawings and samples as appropriate, including:
 - a. Comparison of the qualities of the proposed substitution with that specified.
 - b. Changes required in other elements of the work because of the substitution.
 - c. Effect on the construction schedule.
 - d. Cost data comparing the proposed substitution with the product specified.
 - e. Availability of maintenance service, and source of replacement materials.
3. Architect shall be the judge of the acceptability of the proposed substitution.

C. Contractor's Representation:

1. A request for a substitution constitutes a representation that Contractor:
 - a. Has investigated the proposed product and determined that it is equivalent to or superior in all respects to that specified.
 - b. Will provide the same warranties or bonds for the substitution as for the product specified.

- c. Will coordinate the installation of an accepted substitution into the work, and make such other changes as may be required to make the work complete.
 - d. Waives claims for additional costs, under his responsibility, which may subsequently become apparent.
- D. Architect will review requests for substitutions with reasonable promptness, and notify Contractor, in writing, of the decision to accept or reject the requested substitution.

1.11 MANUFACTURER'S INSTRUCTIONS

- A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including two copies to Architect.
 - 1. Maintain one set of complete instructions at the job site during installation and until completion.
- B. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.
 - 1. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory steps or installation procedure unless specifically modified or exempted by Contract Documents.
 - 2. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Architect for further instructions.
 - 3. Do not proceed with work without clear instructions.

1.12 ADDITIONAL REQUIREMENTS

- A. All equipment and appliances that comprise part of the building mechanical systems regulated by the International Mechanical Code shall be listed and labeled in accordance with the International Mechanical Code.
- B. All listed and labeled equipment shall be installed in accordance with its listing label, manufacturer's installation instructions, and the International Mechanical Code.

- C. Manufacturer's installation instructions shall be available at the job site for use and inspection.

PART 2 - PRODUCTS

2.1 MANUFACTURING STANDARDS

- A. Materials shall be new and designed and/or constructed for their intended use and application. Defective equipment or equipment damaged in the course of installation or test shall be replaced or repaired in a manner meeting the approval of the Architect. Materials to be furnished under this specification shall be the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design. All items of the same type and rating shall be identical.

2.2 ELECTRICAL REQUIREMENTS

- A. Except as otherwise detailed or specified, all interconnecting power wiring required to operate electrical devices and equipment furnished in this Division will be provided under Division 16 Electrical.
- B. All controllers, motors, starters, and individual component fusible protection for all accessory equipment in accordance with NEC, etc. shall be as specified under Division 16 Electrical of the specifications and furnished with equipment under this division. Starters and controllers that are not mounted on the equipment shall be turned over to the Electrical Contractor for installation.
- C. Disconnect switches shall be provided under Division 16 Electrical unless specified in Division 15 Mechanical as integral with equipment.
- D. Requirements for electrical apparatus, devices, controls, etc. furnished in this Division shall conform to Division 16 Electrical.
- E. Control and interlock, wiring and conduit required for electrical devices and equipment furnished in this Division will be provided under this division.

2.3 MOTORS AND MOTOR CONTROLS

- A. All motors furnished as a part of the work of this Division, unless otherwise specified, shall be furnished by the manufacturer of the

equipment served and shall be mounted and aligned so as to run free and true.

- B. All motors shall be provided with a terminal box of adequate size to accommodate the required conduit and wiring. Wire nuts and lugs will be provided under Division 16 Electrical.

PART 3 - EXECUTION

3.1 SCHEDULE OF WORK

- A. The schedule of the mechanical work shall be arranged to suit the progress of work by the other trades and shall in no way retard progress of construction of the building.
- B. Work under this Division shall proceed in advance of the work of others whenever possible, eliminating cutting and patching. When such procedure is impossible, cutting and patching shall be done in an approved manner. Cutting shall not endanger structural function of the building. Patching shall match existing work. Actual work of cutting and patching of existing surfaces shall be performed by the subcontractor who originally prepared these surfaces, e.g., cutting and patching of masonry wall will be performed by the masonry subcontractor. Cutting shall be carefully done and damage to building, piping, wiring or equipment as a result of cutting shall be repaired by skilled mechanics of trade involved. Each Contractor shall furnish sketches showing locations and sizes of all openings, chases, etc. required for installation of his work.
- C. Contractor shall furnish and locate sleeves and inserts required before floors and walls are built. Contractor shall coordinate all drilling required for installation of his hangers.
- D. Exposed piping and ductwork shall be completely installed and ready for painting by General Contractor. Any incorrect and added work installed by Mechanical Contractor after the General Contractor has painted the areas shall be painted at no additional cost to the Owner.
- E. Contractor must cooperate completely with contractors providing equipment under other divisions of the specifications. This is particularly important in accordance with Division 16 Electrical.
- F. Space Priority:

1. Ensure equitable use of available space for materials and equipment installed above ceilings. Allocate space in the order of priority as listed below. Items are listed in the order of priority, with items of equal importance listed under a single priority number.
 - a. Gravity flow piping systems.
 - b. Vent piping systems.
 - c. Ceiling recessed lighting fixtures.
 - d. Concealed air terminal units, fans.
 - e. Air duct systems.
 - f. Forced flow piping systems.
 - g. Electrical conduit, wiring, control wiring.
2. Order of priority does not dictate installation sequence. Installation sequence shall be as mutually agreed by all affected trades.
3. Change in order of priority is permissible by mutual agreement of all affected trades.
4. The work of a particular trade shall not infringe upon the allocated space of another trade without permission of the Contractor for the affected trade.
5. The work of a particular trade shall not obstruct access for installation, operation and maintenance of the work, materials and equipment of another trade.

G. Installation

1. Inaccessible Equipment:
 - a. Where the end user determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the end user.

- b. The term "conveniently accessible" is defined as capable of being reached without the use of ladders 2'-0" greater than the ceiling height, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork. Equipment above ceilings shall be within 12" of top of ceiling.

3.2 BUILDING OPENINGS FOR ADMISSION OF EQUIPMENT

- A. Contractor shall ascertain from his examination of the architectural and structural drawings whether any special temporary openings in the building for the admission of apparatus furnished under this Contract will be necessary, and he shall notify the Architect accordingly. Failure to give this notification in sufficient time for Architect to arrange for same during construction shall not incur any additional cost to the Owner.

3.3 STORAGE AND PROTECTION

- A. Work, fixtures, equipment, and materials shall be protected at all times. The Contractor shall make good damage caused, whether directly or indirectly, by the workmen. Work shall be properly protected to prevent destruction or damage. Pipe and ductwork openings shall be closed with caps and plugs or plastic sheeting during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemical, and mechanical injury.
- B. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible.
 - 1. Store products subject to damage by the elements in weathertight enclosures.
 - 2. Maintain temperature and humidity within the ranges required by manufacturer's instructions.
- C. Exterior Storage:
 - 1. Store fabricated products above the ground, on blocking or skids, prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings, provide adequate ventilation to avoid condensation.
 - 2. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

- D. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.
- E. Protection After Installation:
 - 1. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove when no longer needed.

3.4 TRANSPORTATION AND HANDLING

- A. Arrange deliveries of products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.
 - 1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
 - 2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals, and that products are properly protected and undamaged.
- B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

3.5 CLEANING

- A. Contractor shall be responsible for keeping the premises free of shipping cartons, crates, material scrap, pipe cuttings, etc. related to his work. Floors shall be protected with leakproof pans where pipe cutting or threading operations are in progress.
- B. Prime coated equipment, insulation, piping, and pipe covering shall be left dust-free where painting is not required. Thorough cleaning shall be done where painting is required.
- C. Factory finished painted equipment shall be washed with mild soap and water and left in first class condition, entirely free of stains or streaks. Abrasive materials shall not be used.

- D. Plumbing fixtures shall be cleaned with mild soap and water containing a disinfecting agent. Trim handles shall be set at same angle and trim shall be polished. Aerators shall be removed, cleaned and reinstalled after piping has been cleaned and disinfected. Pop-up wastes shall be checked for proper operation.
- E. Sumps, pits, trenches, manholes, catch basins, and floor drains shall be cleaned and left free of foreign material.

3.6 ELECTRICAL REQUIREMENTS

- A. Except as otherwise detailed or specified, all electrical devices, apparatus, etc., furnished in this Division, but which are not integral with the equipment served, will be installed under Division 16 Electrical.

3.7 EQUIPMENT CONNECTIONS

- A. Contractor shall connect equipment and/or fixtures requiring piping or plumbing connections.
- B. Equipment not particularly specified in this Division of the specification is either specified under other Divisions of these specifications, or furnished by the Owner: Plumbing work in connection therewith is to be included under this Division unless otherwise indicated. Contractor shall carefully examine drawings and other Divisions of the specifications and shall provide roughing-in, including traps, to connect this equipment to the piping or plumbing system, and leave ready for use and operation, with stops, supplies, etc.
- C. Connections to equipment shall be in accordance with shop drawings to be furnished by the equipment supplier.

3.8 SYSTEM START-UP

- A. Provide material and labor required to perform start-up of equipment and system prior to beginning of test, adjust and balance procedures.
- B. Plumbing, air conditioning, heating, and ventilating system shall be operated separately, or in conjunction with the other, for a sufficient period of time to demonstrate to satisfaction of the Architect the ability of the system to meet capacity and performance requirements while maintaining design conditions, in accordance with the true intent and purpose of these specifications. Contractor shall set and adjust mechanical and control equipment, appurtenances and other items as necessary to properly balance phases of the system and shall have the

system operating and maintaining design temperature, humidity, and air circulation throughout the building. Contractor shall provide additional fan sheaves or pump impellers required to obtain design flow rates.

- C. Prior to start of balancing, this Contractor shall review balancing test procedures with the Architect. Contractor shall provide information and assistance as required in cooperation with the test, adjust and balance service.
- D. Start-up procedures shall be as follows:
 - 1. Bearings:
 - a. Inspect for cleanliness, clean and remove foreign materials.
 - b. Verify alignment.
 - c. Replace defective bearings, and those which run rough or noisy.
 - d. Lubricate as necessary, and in accordance with manufacturer's recommendations.
 - 2. Drives:
 - a. Adjust tension in V-belt drives, and adjust varipitch sheaves and drives for proper equipment speed.
 - b. Adjust drives for alignment of sheaves and V-belts.
 - c. Clean, remove foreign materials before starting operation.
 - 3. Motors:
 - a. Check motor for amperage comparison to nameplate value.
 - b. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction.
 - c. Verify rotation and direction of driven equipment is in accordance with design.
 - 4. Valves:

- a. Inspect both hand and automatic control valves, clean bonnets and stems.
 - b. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling.
 - c. Replace packing in valves to retain maximum adjustment after system is judged complete.
 - d. Replace packing on any valve which continues to leak.
 - e. Remove and repair bonnets which leak.
5. Verify that control valve seats are free from foreign material, and are properly positioned for intended service.
 6. Tighten flanges after system has been placed in operation. Replace flange gaskets which show any sign of leakage after tightening.
 7. Inspect screwed and welded joints for leakage. Promptly remake joints which appears to be faulty, do not wait for rust to form. Clean threads on both parts, apply compound and remake joints.
 8. After system has been placed in operation, clean strainers, dirt pockets, orifices, valve seats and headers in fluid systems, to assure being free of foreign materials.
 9. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.
 10. Set and calibrate draft gauges of air filters and other equipment.
 11. Inspect fan wheels for rotation, clearance and balance. Provide factory-authorized personnel for adjustment when needed.
 12. Check electrical control circuit to assure that operation complies with specifications and requirements to provide desired performance.
 13. Inspect pressure gauges and thermometers for calibration. Replace items which are defaced, broken, or which read incorrectly.
 14. Repair damaged insulation.

15. Vent gasses trapped in hydronic or steam systems.
 16. Verify that liquids are drained from gas or air systems.
- E. Provide such periodic continuing adjustment services as necessary to insure proper functioning of mechanical systems after occupancy of the project, and for a period of one year after date of substantial completion.

3.9 COMPLETION OF WORK

A. Plumbing Fixture Caulking:

1. Where irregular walls cause gaps between fixture and wall, Contractor shall fill voids by caulking around fixture.

B. Operating Instructions:

1. Printed instructions, installed in suitable frame with glass front which covers operating and maintenance of each major item of equipment, shall be posted at locations designated by Architect. Bound manuals for equipment operating and maintenance instructions and parts lists shall be turned over to the Owner. Contractor shall carefully instruct Owner's operation man during adjustment and testing period of equipment for each length of time as may be necessary to thoroughly familiarize him with the proper care, operation and maintenance of the equipment.

C. Record Drawings:

1. During construction, the Contractor shall keep an accurate record of deviations between the work as shown on the contract drawings and that which is actually installed. He shall secure a set of blue line prints of the plumbing and mechanical drawings for this purpose, and note changes thereon in red ink, in a neat and accurate manner, thus making a complete record of all changes and revisions in the original design which exist in the completed work. The cost of furnishing above prints and preparing these record drawings shall be included in the contract price by the Mechanical Contractor. When revisions have been shown on these prints to indicate the work as installed, the prints shall be delivered to the Architect, before final payment.

D. Valve and Damper Placement Indication:

1. Where valves and dampers are located above suspended ceilings, an indication device (as approved by the Architect) shall be located in the tile below the device.

E. PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

1. Factory Painting Systems: Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B 117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.10 GUARANTEE OF WORK

- A. Contractor guarantees by his acceptance of the contract that work installed is free from defects in workmanship and/or materials, and that the apparatus will develop capacities and characteristics specified. If, during the period of one year or as otherwise specified from date of certificate of completion, defects in workmanship, material or performance appear, he will, without cost to the Owner, remedy such defects within a reasonable time to be specified in notice from Architect. In default thereof, the Owner may have such work done and charge cost to Contractor. Equipment guarantees from date of "start-up" or "delivery" will not be recognized.
- B. Comply, also, with the General Conditions and the Supplementary Conditions and the applicable Sections of Division 1 General Requirements.

- C. This Contractor shall service the installation for one year from date of substantial completion. This shall include emergency service and adjustment, with the exception of the oiling of motors and cleaning of filters and screens.

END OF SECTION

SECTION 15020 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions apply to work of this section.

1.2 WORK INCLUDED

- A. Piping and equipment identification.
- B. Fire and smoke stopping.
- C. Fabricated steel supports.
- D. Painting.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referenced to in the text by the basic designation only.
 - 1. American Institute of Steel Construction (AISC).
 - 2. American National Standards Institute (ANSI) Standards.
 - 3. American Society for Testing and Materials (ASTM) Publications.
 - 4. American Welding Society (AWS) Publications.
 - 5. Underwriters' Laboratories, Inc. (UL) Standards.

1.4 SUBMITTALS

- A. Comply with Section 15000, "MECHANICAL GENERAL PROVISIONS".
- B. Submit product data for the following:
 - 1. Piping and equipment identification.

2. Fire and smoke stopping material.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Piping and Equipment Identification
 1. Seton Name Plate Corp.
 2. W. H. Brady Co., Signmark Division
 3. Communications Technology Corp.
- B. Fire and Smoke Stopping Material
 1. Dow Corning Corporation.
 2. General Electric Company.
 3. Nelson, A Unit of General Signal.
 4. Chase Technology Corp.

2.2 PIPING AND EQUIPMENT IDENTIFICATION

- A. Pipe markers shall be sub-surface printed plastic, with protective undercoating. Markers shall be permanently curled for snap-on installation and shall identify the pipe contents and direction of flow through 360 degree visibility range. Marker size and letter color and size, shall be in accord with ANSI A13.1. Background color shall be as follows:
 1. Domestic Hot Water - Safety Yellow.
 2. Domestic Cold Water - Green.
 3. Condenser water supply and return - Safety Yellow.
 4. A/C Condensate Drain - Green.
 5. Marker wording shall be in accord with legend on drawings. Markers for outdoor installation shall be covered with outdoor grade acrylic plastic.

- B. Valve tags shall be 19 gauge brass, 1-1/2 inch round, with 1/4 inch high black pipe service letter abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Valve tag attachment shall be 4 ply 0.018 copper wire meter seal.
- C. Valve chart frame shall be self-closing, satin-finished, extruded aluminum with glass window, 8-1/2 inch by 11 inch chart size.
- D. Equipment nameplates shall be 1/16 inch thick plastic with black satin surface and white core. Lettering shall be engraved through the surface color to expose the core color. Plate size shall be 3/4 inch by 2-1/2 inch, with 3/16 inch high lettering. Equipment identifying name and number shall be in accord with schedules on drawings. Plate manufacturer shall furnish nameplates with pre-drilled holes for permanently attaching plate to equipment with self-tapping screws or rivets.

2.3 FIRE AND SMOKE STOPPING

- A. Fire and smoke stopping material shall be a two-part silicone foam or a one-part putty, UL classified, with an HF-1 rating in accord with UL94 and a Class 1 flame spread in accord with ASTM E84. Material shall be suitable for penetration seals through fire-rated floors and walls when tested in accord with ASTM E119. Material shall not melt or soften at high temperatures, shall be suitable for direct outdoor and ultraviolet exposures, shall cure to give a tight compression fit, and shall not produce toxic fumes. Material, when heated, shall expand to fill and hold penetration closed where burn out of cable insulation, ATC tubing, etc. occurs.
- B. Where fire and smoke stopping material does not meet ASTM E84 25/50 flame spread/smoke developed rating, provide 14 gauge metal collar around pipe or duct where penetrating walls and floors in air plenums and air shafts. Provide minimum 1 inch deep neck on collar for attaching to pipe or duct. Neck for pipe collar shall be attached to collar with continuous weld. Neck and collar for duct shall be formed from angle with welded corners. Neck shall extend past sleeve minimum 1 inch all around. Provide collar for each side of wall or floor penetration. Collar may be omitted where permanent damming material meeting ASTM E84 for 25/50 flame spread/smoke developed rating is used and left in place.

2.4 PAINT

- A. Prime and finish paint is provided under DIVISION 09 - FINISHES, except as specified.
- B. All equipment shall be furnished with a factory-applied galvanized, prime paint, or finish paint finish. Touch-up damaged surfaces of equipment immediately.
- C. Paint for galvanized surfaces shall be zinc chromate.
- D. Paint for wooden mounting backboards shall be urea-formaldehyde free with two coats of gray enamel prior to making attachments to the board.
- E. For quality control refer to DIVISION 09 - FINISHES.

2.5 FABRICATED STEEL SUPPORTS

- A. Steel angles, channels, and plate shall be in accord with ASTM A36.
- B. Bolts, including nuts and washers, used for fabricating steel members shall be in accord with ASTM A325.
- C. Welding of steel members shall be in accord with AWS D1.1.
- D. Steel members, including fasteners, exposed to weather shall be galvanized.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of materials and equipment shall be in accord with the manufacturer's written instructions, except as specified.

3.2 PIPING AND EQUIPMENT IDENTIFICATION

- A. Install pipe markers adjacent to each shutoff valve, at each branch connection, at equipment, on each side of wall, floor, and ceiling penetrations, where entering and leaving underground areas, and at intervals not more than 40 feet on horizontal and vertical pipe runs.
- B. In mechanical equipment rooms and equipment areas, install pipe markers adjacent to each piece of equipment, on each side of wall, floor, and ceiling penetrations, and at intervals not more than 20 feet on all pipe runs.

- C. Attach valve tag to stem of each valve. Valve numbers shall follow in sequence the Owner's existing valve numbers, where applicable.
- D. Provide pressure-sensitive vinyl marker for each valve located above lift-out tile ceilings. Apply marker to underside of ceiling grid support system adjacent to valve location. Color of marker shall match color of piping identification system.
- E. Provide triplicate valve charts. Chart information shall indicate job name, Contractor name, date of installation, valve number, valve location, valve purpose, and system in which installed. Mount framed chart in equipment room, and insert copy of chart in each operating and maintenance manual.
- F. Permanently affix nameplate to each item of equipment with self-tapping screws or rivets. Where irregular surface impede direct attachment of plates, affix plate to sheetmetal bracket and attach bracket to equipment with screws or bolts.

3.3 FIRE AND SMOKE STOPPING

- A. Fire and smoke stopping is required in the following locations:
 - 1. Where exposed and concealed horizontal pipes, tubes, and wires penetrate fire rated walls, shaft walls, and smoke barriers.
 - 2. Where exposed and concealed vertical pipes, tubes, and wires penetrate rated and non-rated floors.
 - 3. Where exposed and concealed horizontal ducts penetrate fire rated walls, shaft walls, and smoke barriers, except where fire or smoke dampers are installed in ducts.
 - 4. Where exposed and concealed vertical ducts penetrate rated and non-rated floors, except where fire or smoke dampers are installed in ducts.
- B. Fill annular space between pipe and sleeve, or between duct and sleeve, with approved material. Depth of material shall be in accord with laboratory tests for 1, 2, or 3 hour rated assemblies.
- C. Damming material may be temporary non-fire approved, or permanent fire-approved. Where permanent fire-approved damming material is used depth of fire and smoke stopping material may be decreased in accord

with manufacturer's recommendations. Temporary damming material shall be removed after installation of fire and smoke stopping material.

- D. Seal all gaps or voids in cured foam with material to match the fire and smoke stopping material.
- E. Trim excess cured foam from around all openings and leave smooth, flush surface.
- F. Position metal collar on pipe or duct penetrating floors or walls in air plenums and air shafts. Secure neck of collar to duct with screws, and to pipe with metal draw band.

3.4 PAINTING

- A. Remove all dirt, rust, scale, grease, pipe dope, solder flux, and welding slag from all surfaces to be painted.
- B. Paint immediately, under this DIVISION, all damaged galvanized surfaces, including welds. Paint galvanized metal surfaces behind grilles with two coats of flat black paint.
- C. Apply rust inhibitive primer to ferrous surfaces of shop fabricated steel supports.

3.5 FABRICATED STEEL SUPPORTS

- A. Fabricated steel supports may be shop or field-fabricated, and shall be in accord with details on drawings or as required.
- B. Steel members shall be saw cut, with corners ground smooth, and shall be assembled with welded or bolted connections at Contractor's option. Connections shall be in accord with specified AISC Publications.

3.6 PLACING OF EQUIPMENT

- A. Coordinate setting of equipment with the requirements of other trades so as to avoid conflicts and to insure compatibility. Equipment shall not block access for installation of other equipment.
- B. Set base mounted equipment on permanent and finished supports. Temporary support, if any, shall be removed prior to making final pipe, duct, or electrical connections to equipment.

END OF SECTION

SECTION 15030 - ADJUSTING, BALANCING AND SYSTEM TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this section.

1.2 WORK INCLUDED

- A. Checking installation for conformity to design.
- B. Checking each piece of equipment for proper installation and operation.
- C. Balance of air and water distribution systems including adjustment and measurement. Domestic hot water recirculation systems shall be balanced under this section.
- D. Electrical measurement.
- E. Verification of performance of all equipment and automatic controls.
- F. Checking sound levels and vibration isolators for proper function and measurement and correction where a problem or question of acceptability exists.
- G. Recording and reporting results.

1.3 REFERENCES

- A. Air Diffusion Council (ADC) 1062R3 Equipment Test Code.
- B. Associated Air Balance Council (AABC) National Standards for Field Measurements and Instrumentation, Total Balance System Balance, Air Distribution - Hydronic Systems, Volume 1.
- C. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

1.4 SUBMITTALS

- A. Submit in accordance with General Conditions, Division 1 Sections and Section 15000, "MECHANICAL GENERAL PROVISIONS".
- B. Submit test and balance personnel qualifications.
- C. Submit complete description of procedures to be used prior to beginning of any balancing.
- D. Submit design review report within 45 days after contract award.
- E. Submit Test and Balance Report including schedules of test data readings.

1.5 QUALITY ASSURANCE

- A. Adjusting, balancing and testing procedures and compilation of test data shall be performed by a Certified Test and Balance Engineer or by personnel trained and supervised by a Certified Test and Balance Engineer.
- B. Test and balance personnel shall be qualified to perform testing and balancing in accordance with AABC or NEBB procedures.

1.6 SPECIAL REQUIREMENTS

- A. Testing and balancing contractor shall be an independent contractor under the general contractor. Testing and balancing contractor shall not be associated with the mechanical contractor and shall not report to the mechanical contractor.

1.7 DESIGN REVIEW REPORT

- A. Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the accomplishment of the testing, adjusting, and balancing work requirements of this section or result in unacceptable noise or vibration levels. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

1.8 TOLERANCES

- A. Balance final fluid flows to within plus 10 percent or minus 5 percent of specified quantities. Establish diversity with Engineer prior to proceeding with balancing.

1.9 GENERAL COMMENTS

- A. Water Balance: Readings from venturi flow meters, or automatic pressure independent flow control devices shall be given highest priority as to accuracy. Where neither is specified pump curves and chiller pressure drops are to be correlated to establish flow. Pressure drop across coils or chillers is to be used to proportion flow. Volt and ampere readings will be used as checks. Temperature data will be used only as a performance check and not for balancing.
- B. Air Balance: Readings from a pitot tube traverse will be given highest priority as to accuracy. Terminal flow as established by velometer or manufacturers cfm/pressure curves will be used to pro-rate air flow. Pressure readings as well as voltage and ampere readings will be used for check purposes only. Temperature readings will be used as a check against performance.
- C. Prior to start of balancing, this Contractor shall review balancing test procedures with the Architect. Contractor shall provide information and assistance as required in cooperation with the test, adjust and balance service.

1.10 ACCEPTABLE TAB CONTRACTORS

- A. Virginia Air Balance & Control Corporation (Norfolk, VA)
- B. Testing Specialties Inc. (Chesapeake, VA)
- C. Pure Aire (Virginia Beach, VA)

PART 2 - PRODUCTS

Not applicable

PART 3 - EXECUTION

3.0 TEST AND BALANCE REPORT VERIFICATION

- A. Schedule with Architect, Engineer, and Owner. At the time of final inspection, the Test And Balance (TAB) agency may be required to recheck, in the presence of Engineer representative specific and random selections of data, and water and air quantities recorded in the certified report. Points and areas for recheck shall be selected by the representatives. Selections for recheck will not exceed 20% of the total number tabulated on the report. If random test proves a measured flow deviation of 10% or more from that recorded in the certified report listings, the report will be rejected. At this time all systems shall be readjusted and tested, new data recorded, new certified report submitted, and new inspection tests made, all at no additional cost to the Owner. The TAB agency shall provide the representative with a technician for a maximum of 24 hours in order to verify report data and solve problems.

3.1 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. Review drawings and specifications with regard to adjusting and balancing.
- B. Additional balancing devices which, in the opinion of the Contractor, are required for the adjusting and balancing of the systems should be brought to the Architect's attention in the Design Review Report.
- C. Failure of the Contractor to address such additional means shall not obviate the responsibility of the Contractor to properly adjust and balance the systems.

3.2 WATER BALANCE

- A. Ascertain that piping systems have been cleaned, flushed, drained and properly refilled and that all strainer baskets have been removed, cleaned and properly reinstalled prior to beginning water balancing procedure.
- B. Constant flow pumping system using manual balancing valves and/or butterfly valves with memory stop has been specified for the chilled water and hot water systems.
 - 1. With all balancing devices and valves wide open to coil, read and record pressure drop across each coil.

2. With all balancing devices and valves wide open to coil, read and record pressure drop across each pump. Also read and record pressure drop across pump at shut off. Plot point on submitted pump curve.
 3. If pressure drop across all of the coils exceeds the design and the pump pressure readings indicated a flow in excess of design, the pump impeller may be trimmed. Submit this data to Engineer for early review, before proceeding with balancing to determine if an impeller trim is warranted.
- C. Variable flow pumping systems using manual balancing valves with memory stop have been specified for the chilled and hot water systems.
1. Simulate system diversity by isolating random terminal equipment to approximately match the difference between total connected GPM and pump flow rate. Do not isolate groups at the end, middle, or start of the piping system. Randomly isolate units throughout the system. With balancing devices and valves wide open to the remainder of the terminal units, read and record pressure drop across open coils and across each pump. Also read and record pressure drop across each pump at shut off. Plot point on submitted pump curve.
 2. Redo step one for the terminal units initially isolated with balancing devices and valves wide open while isolating previously balanced terminal coils to simulate system diversity as directed above.
 3. If pressure drop across all of the coils exceeds the design and the pump pressure readings indicated a flow in excess of design, the pump impeller may be trimmed. Submit this data to Engineer for early review, before proceeding with balancing to determine if an impeller trim is warranted.
 4. Do not simulate diversity by balancing all coils to the diversity percentage.

3.3 AIR BALANCE

- A. Check system visually and audibly for leakage and verify filters have been replaced. Proceed with balancing as outlined by AABC or NEBB.
- B. Adjust all air handling apparatus to deliver the specified quantity of air at the specified temperatures to all areas of the building served by air systems.

- C. Determine air volume in ducts by use of pitot tube, and inclined manometer.
- D. Determine air quantity through air devices by use of velometer or flow hood with direct readout meter calibrated in CFM. When using velometer, velometer nozzle shall be as recommended by air device manufacturer. Calculate air quantity based on air device area factors provided by the air device manufacturer. Where manufacturers publish cfm vs. air pressure ratings these may be used as indicators of flow.

3.4 CONTROLS ADJUSTMENT

- A. Check the automatic temperature controls to ascertain that the specified sequence of operation is occurring. Record thermostat or temperature sensor set point and room conditions in each space.
- B. Coordinate onsite meetings during TAB work with the Controls Subcontractor for set point adjustment thru DDC controls.

3.5 TEST DATA SCHEDULES

- A. Submit typewritten schedules of test data readings.
- B. Schedules shall record the specified reading, the first reading taken and the final balanced reading for the following items:
 - 1. Motors:
 - a. Designation.
 - b. Nameplate HP, voltage and full load amperes.
 - c. RPM.
 - d. Motor amperes and voltage under operating conditions.
 - e. For belt drive applications, motor amperes and voltage under no load condition.
 - 2. Fans:
 - a. Designation.
 - b. Nameplate data.
 - c. RPM.
 - d. Static pressure, inlet and discharge.
 - e. CFM from pitot tube traverse of discharge duct.
 - f. Final pitot tube traverse sheets showing all readings.
 - 3. Main and Submain Ducts:

- a. Designation and location.
 - b. CFM from pitot tube traverse.
 - c. Final pitot tube traverse sheets showing all readings.
4. Water Source Heat Pump Units:
- a. Designation.
 - b. Nameplate data.
 - c. CFM, maximum setting on regulator.
 - d. CFM, minimum setting on regulator.
 - e. Final pitot tube traverse sheets showing all readings.
5. Air Outlets and Inlets:
- a. Room designation.
 - b. Type of outlet.
 - c. Design CFM.
 - d. Measured CFM.
 - e. Method of measurement.
 - f. All final measurement readings.
6. Pumps:
- a. Designation.
 - b. Nameplate data.
 - c. RPM.
 - d. Pressure suction and discharge.
 - e. Pressure entering and leaving strainer.
7. Coils - Water:
- a. Designation.
 - b. Nameplate data (if available).
 - c. Pressure entering strainer valve and leaving flow control service.
 - d. Pressure entering and leaving flow control device where two taps are provided.
 - e. Temperature entering and leaving water.
 - f. Static pressure, entering and leaving air.
 - g. Dry bulb and wet bulb temperature, entering and leaving air (4 readings at quarter points where coils are over 20 sq. ft. F.A.)
 - h. CFM over coil including all final readings used to obtain cfm.

- i. GPM from flow regulator nameplate.

3.6 OPERATING TESTS

- A. Verification of HVAC control system. The TAB agency shall coordinate with and be assisted by building controls contractor in verifying the operation and calibration of all HVAC and temp control systems. Verify all components are installed in accordance with project requirements and are functional including all electrical interlocks, damper sequences, air and water resets, fire and freezestats and other safety devices.
- B. Operate systems to demonstrate that systems have been properly adjusted and balanced, and to demonstrate that the systems' performance conforms with the intent of the specifications and drawings.
- C. Conduct tests on each system with natural building heating and/or cooling loads for a minimum 4 hours duration.
- D. Conduct tests for one season only. During season not tested, make adjustments as necessary to demonstrate that the systems' performance in season not tested conforms with the intent of the specifications and drawings.

3.7 EQUIPMENT MARKING

- A. Mark equipment settings, including damper control positions, ductwork balancing dampers, valve indicators, fan speed controls and similar controls and devices, to show final settings at completion of T&B work. Provide markings with paint or other suitable permanent identification materials.

END OF SECTION

SECTION 15250 - INSULATION

PART 1 - GENERAL

1.1 MECHANICAL GENERAL PROVISIONS

- A. The General Provisions of the Contract, including General, Supplementary, and Special Conditions apply to the Work specified in this Section.

1.2 WORK INCLUDED

- A. Duct Insulation
- B. Duct Insulation Accessories
- C. Pipe and Equipment Insulation
- D. Pipe and Equipment Insulation Accessories
- E. Pipe and Equipment Adhesives, Coatings and Sealants

1.3 QUALITY ASSURANCE

- A. Insulation materials, finishes, adhesives, cements, jackets and accessories shall be of the highest grade, shall be the standard products as manufactured by recognized companies, and shall comply with the fire hazard ratings set forth under general and specific requirements specified herein.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referenced to in the text by the basic designations only.
 - 1. American Society for Testing and Materials (ASTM) Publications.
 - 2. Underwriters' Laboratories, Inc. (UL) Standards.
 - 3. National Fire Protection Association (NFPA).

1.5 SUBMITTALS

- A. Submit shop drawings and samples in accordance with Section 15000, “MECHANICAL GENERAL PROVISIONS”.
- B. Submitted shop drawings shall include complete material data and a list of materials proposed for this project. Indicate thickness of material for individual services. Submittal shall indicate compliance with Fire Hazard Ratings and shall give conductance and density of all materials.

1.6 JOB CONDITIONS

- A. Deliver material to job site in original unbroken factory packaging, labeled with manufacturer's name, density, and thickness.
- B. Perform work at ambient and surface temperature as recommended by the adhesive manufacturer.

1.7 FIRE HAZARD RATINGS

- A. Insulation materials, finishes, coatings, cements, jackets and other insulation accessories shall have composite or individual fire hazard ratings which conform to local, state and federal building codes which control building construction materials that may be used in the particular project location.
- B. Duct coverings, duct linings, panels used in duct systems, and other insulation accessories or piping insulation on pipes within air handling plenums or ducts used for air conditioning and ventilating systems shall comply with NFPA-90A, with fire hazard ratings not greater than the following:
 - 1. Insulations and accessories for the various systems and associated equipment shall be composed of materials which are non-combustible and provide a fire-resistive system of insulation which complies with the applicable code having jurisdiction. Generally, fire hazard ratings shall not exceed the following, except as noted:
 - a. Flame Spread Rating - 25 (No Exceptions)
 - b. Smoke Developed Rating - 50

- c. Where permitted by applicable codes, standards, etc., a smoke developed rating greater than 50 may be considered, subject to approval by the Architect/Engineer.
- C. Fire hazard ratings shall be as determined by NFPA-255, "Surface Burning Characteristics of Building Materials" or ASTM E84 or UL 723.
- D. Submittal data covering insulation materials and accessories shall include data sheets which shall positively indicate compliance with the above fire hazard ratings. Where questionable items are submitted, the manufacturer shall submit such additional data as may be requested by the Architect/Engineer to establish compliance.
- E. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411-1982 at their rated temperature (not less than 250°F).

1.8 MISCELLANEOUS REQUIREMENTS

- A. Insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.
- B. Each product container for finishes, adhesives cements, etc., shall bear UL label or shall otherwise indicate compliance with the above fire hazard ratings. Rates of application shall be not less than the rates specified in the manufacturer's published recommendations.
- C. Installation of all insulation work shall be executed by a qualified insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified, and who is familiar with the requirements of the local code enforcing authority as to fire hazard ratings.
- D. Types of insulation, thickness, jackets, finishes, etc., shall be as specified in the Insulation Schedules and Charts for the various types of services listed.
 - 1. The finished installation shall present a neat and acceptable appearance with all jackets smooth, with all joints, laps, seals, etc., properly made and with all vapor barriers sealed and intact.
- E. Unless otherwise herein specified or shown on the drawings, the terms "finished spaces" or "exposed areas" as used herein are intended to include all areas except:

1. Furred spaces.
 2. Pipe and duct shafts which are not accessible for servicing or maintenance operations.
 3. Spaces above furred and suspended ceilings.
 4. Crawl spaces.
 5. Unfinished attics.
- F. Unless otherwise specified or shown on the drawings, the word "concealed" is intended to include all areas except "finished spaces" or "exposed areas" as defined above.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Fiberglass Insulation
1. Certain-Teed Products Corporation
 2. Manville Corporation
 3. Owens-Corning Fiberglas
 4. Knauf
- B. Flexible Elastomeric Insulation
1. Armstrong
 2. Halstead
 3. Rubatex

C. PVC Fitting Covers

1. Zeston (Manville)
2. Foster Products Corp.
3. Proto

D. Accessories

1. Foster Products Corp. (FPC)
2. Chicago Mastic (CM)
3. Childers
4. 3M
5. St. Clair Rubber (SCR)
6. Vimasco (V)
7. Baldwin-Erber-Hill (BEH)

E. These specifications, for purpose of brevity and selection, may mention only one manufacturer's product which shall not preclude the use of equal products of other manufacturers as approved by the Architect.

2.2 MATERIALS

A. Duct Insulation

1. Faced flexible glass fiber duct insulation shall have a fire retardant, reinforced foil/kraft vapor barrier facing and shall be equal to Owens-Corning Fiberglass Faced Duct Wrap Series 100. Insulation shall have a nominal thickness of 2 inches and a thermal conductivity of approximately 0.27 at 75 degrees F.
2. Faced rigid glass fiber duct insulation shall have a fire retardant, reinforced foil/kraft vapor barrier facing and shall be equal to Owens-Corning Fiberglass 700 series. Insulation shall have a nominal thickness of 1-1/2 inches, a thermal conductivity of approximately 0.22 at 75 degrees F, and a density of 3 pounds per cubic foot.

3. Ducts, plenums and housings for air handling equipment having internal liners are not to be insulated on the exterior surfaces. Fire dampers shall be externally insulated. Generally, all medium velocity supply air ductwork will be externally insulated unless noted otherwise.

B. Duct Equipment Accessories

1. Duct Jackets

- a. Where ASJ jackets are specified or scheduled herein, the use of alternative jackets will be permitted subjected to the following conditions:

- (1) The jackets shall, in finished areas, present a final finished surface which is equal to that of the ASJ jacket as to duty and appearance.
- (2) The alternative jacket shall perform the same duty as the ASJ jacket, except that hot ductwork will not require the vapor barrier incorporated in the ASJ jacket.
- (3) In order to avoid the substitution of inferior or inappropriate jackets, all alternative jackets will be subject to review and approval by the Architect.

- b. Faced flexible and rigid fiberglass duct insulation for cold ducts shall have a factory applied finish jacket equal to Owens-Corning Fiberglass FRK fire retardant, vapor barrier, foil laminated to reinforced Kraft facing.

2. Duct Adhesives, Coating and Sealants

- a. Adhesives, coatings and sealants shall meet VOC limits listed in Division 1 Section “Environmental Requirements”.
- b. Adhesives, coatings and sealants shall be compatible with other insulation materials as recommended by the manufacturer. The following is a partial list of services and the corresponding material to be used. Other equivalent products as recommended by the manufacturer may be used, subject to approval of the Architect.

<u>SERVICE</u>	<u>MATERIAL</u>
For gluing laps of ASJ jackets	FPC 85 - 20
For securing flexible fiberglass duct insulation to ducts	FPC 85 - 20
For sealing vapor barriers	FPC 30 - 35
For sealing joints in Fiberglass ASJ sealing tape	ASJ Joint

3. Duct Accessories and Fastening Materials

- a. Staples shall be of the outward clinching type of corrosion resisting steel. Use of staples shall be limited to laps of jackets on flexible blanket duct insulation and other materials and locations as approved by the Architect.

C. Pipe and Equipment Insulation

1. Molded glass fiber insulation for pipes in finished and concealed areas shall be equal to Owens-Corning Fiberglass ASJ/SSL-II pipe insulation with all service jacket, with SSLII self sealing system on all cold lines. Insulation shall have a density of approximately 4.0 pounds per cubic foot and a thermal conductivity of not more than 0.23 at 75 deg. F mean temperature, and shall be suitable for surfaces which reach 450 deg. F.
2. Flexible elastomeric insulation for pipes shall be closed cell type and shall be equal to Armstrong AP Armaflex pipe insulation. Insulation shall have a thermal conductivity of not more than 0.27 at 75 degrees F mean temperature.
3. Pipe and Equipment Jackets
 - a. Adhesives, coatings and sealants shall meet VOC limits listed in Division 1 Section "Environmental Requirements".
 - b. Where ASJ jackets are specified or scheduled herein, the use of alternative jackets will be permitted subject to the following conditions.

- (1) The jackets shall, in finished areas, present a final finished surface which is equal to that of the ASJ jacket as to duty and appearance.
- (2) The alternative jacket shall perform the same duty as the ASJ jacket, except that hot piping and hot equipment will not require the vapor barrier incorporated in the ASJ jacket.
- (3) In order to avoid the substitution of inferior or inappropriate jackets, all alternative jackets will be subject to review and approval by the Architect.

4. Pipe and Equipment Adhesives, Coatings and Sealants.

- a. Adhesives, coatings and sealants shall be compatible with other insulation materials as recommended by the manufacturer. The following is a partial list of services and the corresponding material to be used. Other equivalent and equal products as recommended by the manufacturer may be used, subject to approval of the Architect/Engineer.

<u>SERVICE</u>	<u>MATERIAL</u>
For gluing laps of ASJ jackets	FPC 85 - 20
For sealing vapor barriers	FPC 30 - 35
Fittings, valves, flanges for chilled water piping	FPC 30 - 35 & 30 - 42
For sealing joints in Fiberglass ASJ sealing tape	ASJ joint

5. Pipe and Equipment Accessories & Fastening Materials

- a. Staples shall be of the outward clinching type of corrosion resisting steel. Use of staples shall be limited to laps of jackets on pipe and equipment insulation and other materials and locations as approved by the Architect.
- b. Pre-molded pipe fitting covers shall be one piece PVC sheet material, off white color and shall be equal to Zeston 2000. Use shall be subject to the manufacturer's limitations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Duct Insulation

1. Surfaces to be insulated shall be clean, dry and free from rust and scale when insulation is being applied. Insulation shall be dry at the time of installation and before and during the process of finish application.
2. Insulation shall not be applied before ducts have been proved tight at the specified test pressures.
3. Round flexible connections to air distribution devices shall be externally insulated with flexible, vapor barrier type insulation. Where fire dampers are installed in externally insulated ducts, they shall be externally insulated same as specified for externally insulated ducts. Coordinate Insulation Work with that of ductwork to ensure external insulation overlaps internal liner at least 2 inches.
4. Surfaces of insulation shall be smooth, even and true to line with jackets drawn tight and smoothly secured. Scrap pieces of insulation shall not be used where a full length section will fit.
5. The tops of all diffusers shall be insulated in the same manner as connecting ductwork to prevent condensation.
6. Insulation shall be continuous through non-rated walls, partitions and floors unless otherwise noted.
7. Only experienced mechanics, skilled and trained in the insulation trade, shall be used for application of the insulation materials.

3.2 INSTALLATION

A. Duct Insulation

1. Faced Flexible Glass Fiber
 - a. Insulation shall be tightly wrapped on the ductwork with all circumferential joints butted and longitudinal joints lapped

2 inches and stapled. Joints shall be sealed with approved adhesive. Adhere insulation to ducts with 4 inch wide strips of an approved bonding adhesive, at 12 inches on center. For ducts 24 inches or greater in width, secure insulation to bottom of ductwork with mechanical fasteners spaced at not greater than 18 inches on center.

- b. Insulation shall be butted with facing overlapping all joints at least 2 inches and sealed with approved fire retardant vapor barrier adhesive. Breaks, punctures, pin penetrations in facing shall be sealed with vapor barrier tape and vapor barrier adhesive. Joints shall be taped with vapor barrier tape and vapor barrier adhesive where so recommended by the manufacturer's published installation instructions.

2. Faced Rigid Glass Fiber

- a. Insulation shall be cut and applied using mechanical fasteners. Fasteners shall be located not less than 3 inches from each edge or corner of the board. Pin spacing along the duct shall be no greater than 12 inches on center. Circumferential joints and longitudinal joints shall be sealed with a pressure sensitive joint sealing tape to match the insulation facing.
- b. Insulation shall be butted with facing overlapping all joints at least 2 inches and sealed with approved fire retardant vapor barrier adhesive. Breaks, punctures, pin penetrations in facing shall be sealed with vapor barrier tape and vapor barrier adhesive. Joints shall be taped with vapor barrier tape and vapor barrier adhesive where so recommended by the manufacturer's published installation instructions.
- c. Exterior insulation shall be covered with two coats of weatherproof coating as recommended by the insulation manufacturer over the entire insulation surface. Embed a layer of glass cloth in between coats.

B. Pipe and Equipment Insulation

1. General

- a. Installation of all Insulation Work shall be executed by a qualified insulation contractor who is thoroughly experienced in this particular type of work and who has

adequate facilities and equipment for installation of all insulation work herein specified, and who is familiar with the requirements of the code enforcing authority as to fire hazard ratings.

- b. Types of insulation, thickness, jackets, finishes, etc., shall be as specified in the Insulation Schedule and Charts for the various types of services listed.
- c. The finished installation shall present a neat and acceptable appearance with all jackets smooth, and with all vapor barriers sealed and intact.
- d. Surfaces to be insulated shall be clean, dry and free from rust and scale when insulation is being applied. Insulation shall be dry at the time of installation and before and during the process of finish application.
- e. Insulation shall not be applied before pipe lines have been proved tight at the specified test pressures.
- f. Valves, flanges and fittings, except threaded unions in hot water piping, shall be insulated to the same thickness as the pipe insulation.
- g. The insulation at threaded unions in hot water piping shall be tapered and terminated with cement and glass lagging cloth and lagging adhesives. Insulation shall be continuous through non-rated walls, partitions and floors unless otherwise noted. Refer to the heading FIRESTOPPING AND SMOKESTOPPING.
- h. Insulate exterior surfaces of all anchors and guides for chilled water piping system.
- i. A complete moisture and vapor barrier shall be installed wherever insulation terminates against pipe saddles, hangers or other projections through insulation and in contact with cold surfaces for which a vapor seal is specified. Pipe saddles shall be filled with insulation, and shall be vapor sealed on cold piping.
- j. Nameplates, ASME and other inspection stamps on hot equipment shall not be covered. Metal covers shall be furnished and installed at manhole and thermostat

openings, nameplates and stamps with insulation neatly finished thereto.

2. Molded Glass Fiber Pipe Insulation

- a. Insulation of this type used with copper tubing shall be molded to separate dimensional standards than those of steel pipe.
- b. In finished areas, molded glass fiber insulation or fiberglass pipe wrap shall be used to insulate piping where commercially available sizes can be used.
- c. Fittings on pipe lines in finished and concealed areas shall be covered with flexible fiberglass insulation inserts and premolded pipe fitting covers equal to Zeston 2000 fitting covers where sizes are available. Insulation shall fill the fitting cover and shall not leave any void spaces. The use of premolded pipe fitting covers shall be subject to the limitations set forth by the manufacturer. For sizes where premolded fitting covers are not available use miter-cut segments of molded pipe insulation, wired in place, with all joints sealed with adhesive and smoothed out with a coat of insulating cement. Flanges, strainers, automatic and manual valves shall be insulated with mitered segments of pipe insulation wired in place with joints and raw edges sealed with adhesive and smoothed out with a coat of insulating cement.
- d. On cold pipes, the fittings shall be finished with two coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent pipe insulation. Where premolded pipe fitting covers (Zeston 2000) are used, the vapor barrier shall lap over and onto the adjacent pipe insulation. Hot pipes shall be finished in a similar manner, except the mastic need not be of the vapor barrier type.

3.3 FIELD QUALITY CONTROL

Visually inspect to ensure that materials provided conform to specifications. Inspect installations progressively for compliance with requirements.

A. Air Distribution Systems

Obtain written approval of systems under Section 15030, "ADJUSTING, BALANCING AND SYSTEM TESTING" before applying field insulation to air distribution systems.

B. Piping Systems

Obtain Contracting Officer's written approval of HVAC water distribution systems under Section 15030, "ADJUSTING, BALANCING AND SYSTEM TESTING" before applying field-applied insulation to HVAC water distribution systems. At Contractor's option and with Contracting Officer's written approval, piping systems may be insulated before systems are tested, adjusted, and balanced (TAB'd). Piping insulation shall terminate immediately adjacent to each flow control valve, automatic control valve, or device. For chilled water and chilled-hot water piping systems, seal ends of pipe insulation and space between ends of pipe insulation and piping with waterproof vapor barrier seating. After systems are TAB'd, insulate control valves and devices.

3.4 SCHEDULE

A. Duct Insulation

Service	Type Insul	Finishes		Notes
		Concealed Areas	Finished Areas	
Concealed Interior Low Pressure A.C.	Flexible Glass Fiber	FRK Vapor Barrier	FRK Vapor Barrier	
Supply Outside & Mixed Air & Fire Dampers	Flexible Glass Fiber	FRK Vapor Barrier	FRK Vapor Barrier	
Return	* Flexible Glass Fiber	FRK Vapor Barrier	FRK Vapor Barrier	

* Unless otherwise noted on drawings or specifications.

B. Pipe Insulation

Domestic H.W. & H.W. Return	Rigid Glass Fiber A/3	ASJ/SSL-II	ASJ/SSL-II
Domestic C.W.	Rigid Glass Fiber A/6	ASJ/SSL-II	ASJ/SSL-II
Interior A.C. Condensate Drain & Water Cooler Drain	Rigid Glass Fiber A/9	ASJ/SSL-II	ASJ/SSL-II
*Floor Drains Plus 20' of drain pipe from F.D.	Rigid Glass Fiber A/10	ASJ/SSL-II	ASJ/SSL-II

*Note: Applies to floor drains above first floor receiving cold condensate.
 Note: Flexible elastomeric pipe insulation may be used in lieu of rigid glass fiber
 on A.C. condensate and refrigerant suction.

NOTE: Provide corrugated or smooth aluminum jacket for all insulated pipes 0'-0" to
 6'-0" above finished floors and mezzanines for insulation protection.

CHART A
 PIPE INSULATION THICKNESS BASED ON RIGID GLASS FIBER

Refer Line No.	Piping System	System Temp. Range Deg. F	Insulation thickness in inches for Pipe Sizes (R=4.0 - 4.6)				
			1" & Less	1-1/4" -2"	2-1/2" -4"	5-6"	8" or larger
Cooling Systems							
Domestic Water Systems							
1	Domestic Hot Water & H.W. Return	110-140	1	1	1-1/2	1-1/2	1-1/2
2	Domestic Cold Water	48-80	1/2	3/4	1	1	1
3	Interior A.C. Condensate Drain & Water Cooler Drain	All	1/2	3/4	--	--	--
4*	Floor Drains	All	--	1/2	1/2	--	--

* NOTE: Applies to floor drains above the first floor receiving cold condensate.

END OF SECTION

SECTION 15400 - PLUMBING

PART 1 - GENERAL

- 1.1 **APPLICABLE PUBLICATIONS:** The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- A. American National Standards Institute (ANSI) Publications
 - B. American Society for Testing and Materials (ASTM) Publications
 - C. American Society of Sanitary Engineers (ASSE) Publications
 - D. American Water Works Association (AWWA) Publications
 - E. Cast-Iron Soil Pipe Institute (CISPI) Publications
 - F. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Publications
 - G. Plumbing and Drainage Institute (PDI) Publications
 - H. North Carolina State Plumbing Code
 - I. North Carolina Uniform Statewide Building Code (VUSBC)
- 1.2 **GENERAL REQUIREMENTS:** Section 15000, "Mechanical General Provisions", applies to this section, with the additions and modifications specified herein.
- 1.3 **DESCRIPTION OF WORK:** The work includes [modifying existing and] providing new plumbing systems and related work. The work also includes providing roughing-in and making final plumbing connections to equipment furnished under other sections of this specification. Provide each system complete and ready for operation. Plumbing systems including fixtures, equipment, materials, installation, workmanship, examination, inspection, and testing shall be in accordance with the ICC International Plumbing Code, except as modified herein. In the Plumbing Code referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for the word "should" wherever it appears. Capacity of equipment shall be not less than that indicated. Plumbing systems shall include all water and sanitary piping[buried and above ground except water and sanitary piping more than 5 feet outside of the building walls is specified in Division 2.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with 15000, “MECHANICAL GENERAL PROVISIONS”.
- B. Manufacturer's Data:
 - 1. Pipe and fittings
 - 2. Valves
 - 3. Plumbing fixtures
 - 4. Water heaters
 - 5. Pipe supports (hangers)
 - 6. Pumps
 - 7. Gages and thermometers
 - 8. Strainers
 - 9. Drains
 - 10. Water hammer arresters
 - 11. Backflow preventers
 - 12. Insulation kits for barrier free fixture fittings
- C. Shop Drawings:
 - 1. Access panels
- D. Certificates of Compliance:
 - 1. Pipe and fittings
 - 2. Valves
 - 3. Water flushing volume of flushometer and urinal combination
 - 4. Water flushing volume of flushometer and water closet combination
 - 5. Backflow preventers
- E. Certified Data:
 - 1. Water heaters
 - 2. Pump test curves
 - 3. Backflow preventers
- F. Operation and Maintenance Manuals:
 - 1. Water heaters
 - 2. Pumps
- G. Posted Operating Instructions:

1. Water heaters
 2. Pumps
- 1.5 INSULATION: Insulate equipment and piping under this section as specified in Section 15250, "Insulation", except as specified herein for barrier free accessible fixtures and fittings.
- 1.6 FIELD PAINTING: Provide under Section "Field Painting".
- 1.7 FLASHING: Provide under Section "Flashing and Sheet Metal".
- 1.8 ELECTRICAL REQUIREMENTS: Furnish motors, controllers, contactors, and starters with their respective pieces of equipment. Motors, controllers, contactors, and starters shall conform to and shall have electrical connections provided under Division 16. Controllers and contactors shall have a maximum of 120-volt control circuits, and auxiliary contacts for use with the controls furnished. Disconnect switches shall be provided under Division 16 unless specified in this section as integral with equipment. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

PART 2 - PRODUCTS

- 2.1 DWV (DRAIN, WASTE, AND VENT) PIPING: Fittings shall be long radius fittings, except fittings in vent piping may be short radius fittings. Minimum size piping shall be 2 inches for buried piping and 1.5 inches for aboveground piping.
- A. Buried Piping: Buried piping includes piping up to but not more than 6 inches above ground or floor slab on grade.
1. Plastic Pipe: PVC, (DWV) Schedule 40, ASTM D2665, or ABS Sewer Pipe, ASTM D2661 may be installed as permitted by code. PVC and ABS pipe shall not be installed in locations where temperatures will be above 140 degrees F.
- B. Aboveground Piping:
1. Cast-Iron Hubless Pipe and Fittings: CISPI 301 with CISPI 310 coupling joints.
 2. Cast-Iron Hub and Spigot Pipe and Fittings: ASTM A 74 with ASTM C 564 rubber compression gasket joints, or caulked and leaded joints.

3. Plastic Pipe: PVC, (DWV) Schedule 40, ASTM D2665 or ABS Sewer Pipe, ASTM D2661 may be installed as permitted by code.
 4. Copper Tubing: ASTM B 306, with ANSI B16.23, ANSI B16.29, or ANSI B16.32 solder joint fittings using ASTM B 32, 95-5 tin-antimony solder.
 5. Steel Pipe: ASTM A 53 or ASTM A 120, Schedule 40, hot-dip galvanized, threaded end connections; with ANSI B16.12 hot-dip galvanized threaded fittings.
- C. Cleanouts: ANSI A112.36.2; provide threaded bronze or thermoplastic cleanout plugs.
1. Floor Cleanouts: Provide cast-iron floor cleanout with flange, polished bronze or nickel bronze rim and scoriated floor plate with CO cast in the plate. Secure floor plate with countersunk screws for installation flush with finished floor.
 2. Wall Cleanouts: Provide polished stainless steel or chromium-plated bronze cover plate and secure to cleanout plug with countersunk screw.
 3. Cleanouts Exterior to Buildings: Provide cast-iron cleanouts and countersunk plugs. Provide 24- by 24- by 4-inch thick concrete slab with top 1.0 inch above grade with cleanout located in center of slab. Provide cast-iron cleanout box with cover.
- D. Drains: ANSI A112.21.1M; provide cast-iron drains and clamping rings for use with membrane waterproofing.
1. Flush Strainer Floor Drains: Provide with double drainage flange, perforated or slotted cast bronze or nickel bronze strainer, adjustable collar, and P-trap. Provide with trap primer connection where indicated.
 2. Automatic Trap Primer: Provide automatic floor drain trap primer with integral backflow preventer and vacuum breaker on all floor drains. Precision Plumbing Products, Inc. or approved equal.
 3. Mechanical Room and Area Drains: Provide with heavy-duty cast-iron grate and sediment bucket.
 4. Roof Drains: ASME A112.21.2; provide hot-dip galvanized cast-iron drains, with minimum of 10-inch diameter body, nonpuncturing

flashing clamp device with integral gravel stop and deck clamp, and removable cast-iron dome. Plastic domes are not acceptable. Free area of dome shall be not less than two times the free area of drain outlet. Provide drain flashing ring seat flush with adjacent roof deck, and secure rigidly in place with deck clamp. Provide 3-1/2" high water dam on drains indicated as overflow drains.

5. Downspout Nozzle: Provide [nickel bronze] [polished bronze] downspout nozzle, size and location as indicated on drawings, to discharge rain water from concealed rain leaders to ground. Design shall be to divert water away from building eliminating wall stains. A wall flange shall cover rough opening and serve as an anchor.

2.2 DOMESTIC WATER PIPING

A. Buried Piping and Aboveground Piping:

1. Copper Tubing: ASTM B 88, Type K, with ANSI B16.18 or ANSI B16.22 solder joint fittings using ASTM B 32, grade Sn 96 tin-silver solder and flux containing not more than 0.2 percent lead, or with ANSI B16.26 flared joint fittings. ASTM B 88, Type L, shall be provided for aboveground piping.

B. Water Valves: Provide valves suitable for minimum of 125 psig and minimum of 180 degrees F hot water in accordance with MSS SP-80-79. Valves shall have threaded end connections with a union on all but one side of the valve, or solder end connections for connections between bronze valves and copper tubing. Copper alloy and bronze valve body shall be ASTM B 61 or ASTM B 62 copper alloy. Ball valves may be provided in lieu of gate valves.

1. Acceptable Manufacturers: Valves shall be of one manufacturer for each type of valve. Where valve manufacturers are not specifically indicated below, they shall be one of the following: Crane, Jenkins, Stockham, Nibco, Scott, Grinnel or Red & White.
2. Valve Connections: Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use line size valves.
3. Ball Valves: Ball valves used in connection with piping 2 inches in size and smaller, shall have screwed or sweat ends, bronze body, bronze ball and resilient seal. Valve shall be serviceable from either top or end without removing piping. For water service, valves shall be designed for 200 lbs. WOG and 250 degrees F.

4. Hose Bibbs: Provide angle type copper alloy globe valve with lock-shield and handwheel. Inlet shall have internal threads. Outlet shall have vacuum breaker with 0.75-inch external hose threads.
5. Reduced Pressure Backflow Preventers: Provide ASSE 1013 approved reduced pressure backflow preventers where indicated, as manufactured by Watts 900 Series, or equal by Febco or Conbraco. Provide strainer with blow down valve upstream of device in accordance with manufacturer's recommendations. Provide with air gap fitting piped to nearest floor drain or other approved location.
6. Check Valves: Check valves in piping 2 in. and smaller shall be bronze body, renewable bronze disc screwed or sweat ends, designed for 125 lbs. steam pressure.
7. Vacuum Breakers:
 - a. Hose outlet vacuum breakers - 3/4 in. size, stainless steel and cast brass construction, plated as faucet to which attached, equal to Watts #NF-8.
 - b. Other vacuum breakers - angle, pressure type, brass body, equal to Watts 288A or Nibco 715. Vacuum breakers on chrome-plated piping similarly plated.
8. Vacuum Relief Valves: Bronze body construction with silicone disc equal to Watts model 36A.
9. Pressure Relief Valves: Bronze or cast-iron body, with test lever, and shall be suitable for the intended service.
10. Manual Balance Valves (Hot Water Recirculation System):

Flow Control Balancing Valves: Copper alloy body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 125 psig at 190 degrees F hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tappings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the gallons per minute flow for each differential pressure reading.

- C. Dielectric Connections: Provide at connections between copper and ferrous metal piping materials. ASTM F 441, Schedule 80, CPVC threaded pipe nipples, 4-inch minimum length, may be provided for dielectric connections in pipe sizes 2 inches and smaller.
 - D. Water Hammer Arresters: Expansion bellows type with pressurized compression chamber; ANSI A112.26.1, OR ASSE 1010.
 - E. Wall Hydrant: Wall hydrant, exposed type with vacuum breaker/backflow preventer, wall mounted, automatic draining, freezeproof, key operated, polished brass finish on brass casting. Woodford model 65 or approved equal by Zurn or Josam.
 - F. Pressure Gauge: Provide single style pressure gage for water with 4.5-inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubber, and syphon. Provide scale range suitable for the intended service.
 - G. Thermometers: Provide bi-metal dial type thermometers with stainless steel case, stem, and fixed thread connection; 5-inch diameter dial with glass face gasketed within the case; accuracy within 2 percent of scale range. Provide scale range suitable for the intended service.
- 2.3 EXPANSION TANK: Drawn steel tank with butyl diaphragm, 150 psi max. working pressure, in-line type, field adjustable air charge, suitable for use in potable domestic cold water systems.
- 2.4 MISCELLANEOUS PIPING MATERIALS
- A. Pipe Nipples: Copper alloy for use in copper tubing and hot-dip galvanized Schedule 80 steel pipe for use in steel piping.
 - B. Escutcheon Plates: Provide one piece or split hinge type metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide chromium-plated finish on plates in finished space. Provide paint finish on plates in unfinished spaces. Securely anchor plates in place with set screws or other approved positive means.
 - C. Pipe Sleeves: Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors. Provide one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or

provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

1. Sleeves in Masonry and Concrete: Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth. PVC sleeves shall not be used in walls adjacent to plenum spaces.
 2. Sleeves Not in Masonry and Concrete: Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves. PVC sleeves shall not be used in walls adjacent to plenum spaces.
- D. Pipe Supports (Hangers): Provide MSS SP-58 and MSS SP-69, Type 1, Type 7, or Type 12, of the adjustable type, except as indicated or specified herein. Provide Type 40 insulation protection shields for insulated piping. Provide steel support rods. Provide nonmetallic, hair felt, or plastic piping isolators between copper tubing and the hangers. Provide flat wide band hangers for un-insulated plastic piping.
- E. Access Panels: Provide factory prefabricated and primed steel access panels including 16-gage steel frame with a hinged or snap-on 14-gage steel cover with spring-catch or turn-latch. Provide panel with factory-primed rust-inhibitive paint. the wide-leg or flange of the frame section shall be perforated or shall extend into expanded metal wings to provide a key for plaster. Size and furnish panels under this section to provide proper access to concealed valves and control devices; install panels under the appropriate section of this specification.
- 2.5 FIXTURES, FITTINGS, ACCESSORIES, AND SUPPLIES: Provide control-stop valves in each supply to each fixture. The finish of fittings, accessories, and supplies exposed to view shall be chromium-plated. Zincolloy or plastic handles will not be permitted for faucets and valves. Provide special roughing-in for wheelchair fixtures. Exposed traps, supplies and stop valves at barrier free fixtures shall be insulated with ANSI and ADA approved, vinyl molded insulation with nylon fastener kits, painted as directed by the Architect. Fixtures shall be as manufactured by American Standard, Kohler or Eljer. Model numbers provided are to indicate desired quality and style, others will be considered if approved equal by the Architect/Engineer.
- A. Water flow rates and water consumption for fixtures shall be as follows:

Water closets:	1.6 GPM per flushing cycle
Urinals:	1.0 GPM per flushing cycle
Lavatories:	0.5 GPM at 80 psi
Lavatories with self metering faucets:	0.25 gallons per cycle
Sinks:	2.2 GPM at 60 psi
Shower heads:	2.5 GPM at 80 psi

2.6 DOMESTIC WATER HEATERS (ELECTRIC)

- A. Storage Tank Type: UL 174, electric water heaters, glass-lined steel tanks, high efficiency type insulated with polyurethane foam insulation, replaceable anodes, conforming to ASHRAE 90A requirements, with adjustable range thermostat to allow hot water settings between 110 and 160 degrees F of size and capacity as shown on the drawings, as manufactured by State or approved equal. Provide posted operating instructions for water heaters. Water heaters with input ratings greater than or equal to 58 kw; or a storage capacity greater than or equal to 120 gallons shall be constructed in accordance with ASME standards and bear the ASME stamp.
- B. Furnish and install a drain pan under water heater. Drain pan shall be not less than 1-1/2" deep and shall be of sufficient size and shape to receive all dripping or condensate from the tank or water heater. The pan shall be drained by an indirect waste pipe having a minimum diameter of 1 inch or the outlet diameter of the required relief valve whichever is larger. The pan drain shall extend full size and terminate over a suitably located indirect waste receptor, floor drain or extend to the exterior of the building and terminate not less than 6 inches nor more than 24 inches above finished grade.
- C. Heater shall be covered by a 5 year limited commercial warranty against tank failure.
- D. Refer to drawings for design basis of solar hot water as an additive bid item.

2.7 PUMPS: Submit for approval the manufacturer's certified characteristic performance curve for the impeller size to be furnished. Select the pump so that the operating point on the characteristic performance curve for the impeller size to be furnished will be to the left. (shut-off side) of and not more than 5 percent below the point of maximum efficiency for the impeller to be furnished.

- A. Inline Water Pumps: Capacity as indicated on the drawings.
- B. Submersible Sump Pumps: Provide factory assembled and tested submersible type pumps for operation under water. Pump shall be complete with cast-iron casing, bronze impeller, stainless steel shaft, sealed heavy-duty

ball bearings, water-cooled hermetically-sealed motor, built-in automatic reset thermal protection, mercury float switch, and waterproof three-conductor cables and grounding plug.

PART 3 - EXECUTION

- 3.1 **INSTALLATION:** Installation of plumbing systems including fixtures, equipment, materials, and workmanship shall be in accordance with the ICC International Plumbing Code, except as modified herein. When fixtures require both hot water and cold water supplies, provide the hot water supply to the left of the cold water supply. Plastic piping shall not penetrate fire walls.
- A. **Threaded Connections:** Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape, pipe cement and oil, or PTFE powder and oil; apply only on male threads. Provide exposed ferrous pipe threads with one coat of primer applied to a minimum dry film thickness of 1.0 mil.
 - B. **Pipe Supports (Hangers):** In accordance with the ICC International Plumbing Code or MSS-SP-69. Provide additional supports at the concentrated loads in piping between supports, such as for inline water pumps and flanged valves.
 - 1. **Piping to Receive Insulation:** Provide temporary wood spacers between the insulation protection shield and the pipe in order to properly slope the piping and to establish final elevations. Temporary wood spacers shall be of the same thickness as the insulation to be provided under Section 15250, "Insulation".
 - 2. **Maximum Spacing Between Supports:**
 - a. **Vertical Piping:** Support metal piping at each floor, but at not more than 10-foot intervals. Support plastic piping at 4 foot intervals.
 - b. **Horizontal Piping:** Support cast-iron piping at 5-foot intervals, except for pipe exceeding 5-foot length, provide supports at intervals equal to the pipe length but not exceeding 10 feet. (Support plastic piping at 4-foot intervals.) Support steel piping and copper tubing as follows:

MAXIMUM SPACING (FEET)

Nominal Pipe Size (inches)	One and under	1.25	1.5	2	2.5	3	4	6
Steel Pipe	12	12	12	12	12	12	12	12
Copper Tube	6	6	10	10	10	10	10	10

- 3.2 NAMEPLATES: Provide laminated plastic nameplates for equipment, gages, and valves; stop valves in supplies to fixtures will not require nameplates. Laminated plastic shall be 0.125-inch thick melamine plastic, black with white center core. Surface shall be a matte finish. All corners shall be square. Accurately align lettering and engrave into the white core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches. Lettering shall be minimum of 0.25-inch high normal block lettering. Key the nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule. Each inscription shall identify its function. Equipment nameplates shall show the following information.
- A. Manufacturer, type, and model number
 - B. Capacity or size
 - C. System in which installed
 - D. System which it controls
- 3.3 DISINFECTION: Disinfect the new water piping in accordance with AWWA C651 or C652. Fill the piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush the solution from the systems with clean water until the chlorine is purged from the system.
- 3.4 FIELD TESTING: Before final acceptance of the work, test each system as in service to demonstrate compliance with the contract requirements. Perform the following tests in addition to the tests specified in the ICC International Plumbing Code, except as modified herein. Correct all defects in the work provided by the Contractor, and repeat the tests until the work is in compliance with contract requirements.
- A. Domestic Water Piping: Before insulation is applied, hydrostatically test each piping system at not less than 100 psig with no leakage or reduction in gage pressure for 2 hours.

- B. DWV Piping: Before the installation of fixtures, cap the ends of each system, fill the piping with water to the roof, and allow to stand until a thorough inspection has been made. After the plumbing fixtures have been set and their traps filled with water, subject the entire sanitary system to a final air pressure test of not more than 1.0 inch of water column. The entire system must be proven absolutely tight under such test.

END OF SECTION

SECTION 15480 - EXCAVATION, TRENCHING, AND BACKFILLING
FOR UTILITIES SYSTEMS

PART 1 - GENERAL

- 1.1 REFERENCES: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1.2 DEFINITIONS

- A. Degree of Compaction: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

- 1.3 SUBMITTALS: The following shall be submitted in accordance with Section 15000, Mechanical General Provisions.

SD-09 Reports: Field Density Tests. Testing of Backfill Materials.

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Materials: Satisfactory materials shall consist of any material classified by ASTM D 2487 as GW, GP, and SW.
- B. Unsatisfactory Materials: Unsatisfactory materials shall be materials that do not comply with the requirements for satisfactory materials. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches, and materials classified in ASTM D 2487, as PT, OH, and OL. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction.
- C. Cohesionless and Cohesive Materials: Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.
- D. Rock: Rock shall consist of boulders measuring 1/2 cubic yard or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits, and below ground concrete or masonry structures, exceeding 1/2 cubic yard in volume, except that pavements will not be considered as rock.
- E. Unyielding Material: Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.
- F. Unstable Material: Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.
- G. Select Granular Material: Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 3 inches, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

- H. Initial Backfill Material: Initial backfill shall consist of select granular material or satisfactory materials free from rocks 3 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 1 inch in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

PART 3 - EXECUTION

- 3.1 EXCAVATION: Excavation shall be performed to the lines and grades indicated. Rock excavation shall include removal and disposition of material defined as rock in paragraph MATERIALS. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to \square the depth of the excavation, but in no instance closer than 2 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating therein shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost.
- A. Trench Excavation: The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than 30 feet high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Vertical trench walls more than 5 feet high shall be shored. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter and shall not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost.

1. Bottom Preparation: The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.
2. Removal of Unyielding Material: Where unyielding material is encountered in the bottom of the trench, such material shall be removed 4 inches below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.
3. Removal of Unstable Material: Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the fault or neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the Contractor without additional cost.
4. Excavation for Appurtenances: Excavation for manholes, catch-basins, inlets, or similar structures shall be sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.
5. Stockpiles: Stockpiles of satisfactory, unsatisfactory, and wasted materials shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may

destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost. Locations of stockpiles of satisfactory materials shall be subject to prior approval of the Activity.

3.2 BACKFILLING AND COMPACTION: Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

- A. Trench Backfill: Trenches shall be backfilled to the grade shown. The trench shall not be backfilled until all specified tests are performed.
1. Replacement of Unyielding Material: Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.
 2. Replacement of Unstable Material: Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 6 inches loose thickness.
 3. Bedding and Initial Backfill: Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.
 4. Final Backfill: The remainder of the trench, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:
 - a. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. This requirement

shall also apply to all other areas not specifically designated above.

- B. Backfill for Appurtenances: After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.
- 3.3 TESTING: Testing shall be the responsibility of the Contractor and shall be performed at no additional cost.
- A. Testing Facilities: Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Activity.
 - B. Testing of Backfill Materials: Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils ASTM D 422 and moisture-density relations of soils ASTM D 1557. A minimum of one particle size analysis and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.
 - C. Field Density Tests: Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 30 feet of installation shall be performed. One moisture density relationship shall be determined for every 1500 cubic yards of material used. Field in-place density shall be determined in accordance with ASTM D 1556. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Activity. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost.

END OF SECTION

SECTION 15700 - HEATING, VENTILATING, AND COOLING SYSTEM

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
1. Association of Home Appliance Manufacturers (AHAM)
 2. Air Movement and Control Association, Inc. (AMCA)
 3. American National Standards Institute (ANSI)
 4. Air-Conditioning and Refrigeration Institute (ARI)
 5. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)
 6. American Society of Mechanical Engineers (ASME)
 7. American Society of Sanitary Engineering (ASSE)
 8. American Society for Testing and Materials (ASTM)
 9. ETL Testing Laboratories (ETL)
 10. Foundation for Cross-Connection Control and Hydraulic Research (FCCCHR)
 11. Gas Appliance Manufacturers Association (GAMA)
 12. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 13. National Electrical Manufacturers Association (NEMA)
 14. National Fire Protection Association (NFPA)
 15. National Roofing Contractors Association (NRCA)

16. Sheet Metal & Air Conditioning Contractors' National Association, Inc. (SMACNA)
17. Underwriters Laboratories Inc. (UL)

1.2 SYSTEM DESCRIPTION

Provide new heating, ventilating, and cooling (HVAC) systems complete and ready for operation. HVAC systems include equipment, ducts, and piping which is located within, on, under, and adjacent to buildings.

1.3 SUBMITTALS

Submit the following in accordance with section entitled Section 01300 "SUBMITTALS".

- A. Manufacturer's Catalog Data
 1. Water-source heat pumps
 2. Pump modules
 3. Ground heat exchanger piping system
 4. Unit heaters
 5. Exhaust fans
 6. Diffusers, registers, and grilles
 7. Exhaust air louvers
 8. Fire dampers
 9. Linear Diffusers
 10. Specialty Valves
 11. Dielectric Connections
- B. Drawings
 1. Temperature control systems
 - a. Temperature Control Systems

Drawings shall include point-to-point electrical wiring diagrams.

C. Instructions

1. Installation manual

a. Installation Manual

Provide for each item of equipment.

D. Statements

1. Certification of welders' qualifications

a. Certification of Welders' Qualifications

Submit copy of Welder Qualification Tests (Form QW-482) prior to site welding. Certification shall not be greater than one year old.

2. Equipment field test plans

a. Equipment Field Test Plans

Submit within 120 calendar days after contract award for the following equipment. Submit equipment field test plans to Architect for review and approval.

(1) Water source heat pumps.

(2) Pump modules.

E. Field Test Reports

1. Water-source heat pumps

2. Pump modules

Submit field test reports to Architect for review and approval.

F. Certificates

1. Fire dampers

G. Operation and Maintenance Manuals

1. Water-source heat pumps
2. Pump modules
3. Unit heaters
4. Exhaust fans
5. Fire dampers

Submit in accordance with Section "OPERATION AND MAINTENANCE DATA".

PART 2 - PRODUCTS

2.1 EQUIPMENT

Equipment using refrigerants R-11, R-12, R-113, R-114, R-115, R-500, or refrigerants with ozone depletion factor (ODF) greater than 0.05 shall not be permitted.

A. Water-Source Water-to-Air Heat Pumps (WSHP)

Provide water-source water-to-air heat pump units and ground-coupled, water-to-air heat pump units factory assembled, designed, tested, and rated in accordance with ARI/ISO 13256.1. Units shall be ARI certified, or listed in ARI directory.

Units shall include fans, refrigerant-to-air heat exchangers, filters, compressor, reversing valve, expansion valve, and refrigerant-to-water heat exchangers.

1. Cabinet: Provide manufacturer's standard galvanized steel cabinet finished. Provide access panels for inspection and access to internal parts. Insulate cabinet with minimum 2 inch multi-density, fiberglass insulation with exposed edges sealed or tucked under flanges to prevent introduction of fibers into the air stream. Female threaded pipe condensate drain connections, supply water connections, and return water connections shall be copper or brass threaded fittings mechanically fastened to the cabinet. Water piping shall be insulated. Construct cabinet with compartments and

locate the compressor, reversing valve, and water coil out of the air stream. Insulate the divider between the compressor and fan sections. The control box shall be located within the unit.

2. Fans: Provide centrifugal type, direct drive fans with permanently lubricated motors. Motors shall be multi-speed, Permanent Split Capacitor (PSC) type with thermal overload protection. Wheel and housing shall be designed for quiet operation and efficient air delivery. The blower shall be mounted on permanently lubricated, maintenance-free ball bearings. The drive packages shall be designed for external static pressures sufficient to overcome system resistances.
3. Filter Section: Provide replaceable (throwaway) filter 2 inch thick UL listed fiberglass; permanent washable type filters with standard dust-holding capacity. Mount filters in filter frames and provide access panels or doors for removal and replacement of filters.
4. Compressor: Provide hermetically sealed type compressor, installed on vibration isolators enclosed in an acoustically treated enclosure. Provide high and low pressure switches, motor thermal overload protection, low suction temperature cut-out/coil freeze stat, 5 minute anti-recycle timer, and start capacitor kit. Provide units with factory installed sound attenuation package to meet noise criteria (NC) level based on ARI 260D Standard.
5. Reversing Valve: Provide solenoid activated refrigerant reversing valves energized only during the cooling mode and designed to fail in the heating position.
6. Refrigerant-to-Water Heat Exchangers: Provide refrigerant-to-water heat exchangers of coaxial type, with copper/nickel tubes. Heat exchanger shall be tested and rated for 450 psi refrigerant working pressure. A thermal expansion valve assembly shall provide refrigerant metering and be sized by the manufacturer for proper superheat settings.
7. Provide UL listed, electric resistance heater with internal fusing integral with heat pump unit; fan shall run until heater cools. Locate downstream of indoor coil.
8. Hose Kits: Unless otherwise noted on the contract drawings, hose kits shall include two - 2 foot long metal braided stainless steel hoses with swivel connectors on one end, an automatic flow control valve with test ports, blow down ball valve, and Y-strainer.

Hoses shall be fire rated to meet UL 94. Hoses shall have a maximum working pressure of 300 psi.

9. Space temperature controls: Provide manufacturer's thermostats. Thermostats shall be furnished by unit manufacturer. Provide relays, transformers, contactors, and control wiring between thermostats and unit.

B. Pump Modules

Provide pump module units factory designed, assembled, and pressure tested. Units shall include flanged pumps, brass fill and purge valves, quick release fill and purge ports, pressure/temperature (Pete's) plug, wiring, and fuse protection. Pumps shall be the wet rotor and single stage types, with pump casings thermally insulated. Provide manufacturer's standard galvanized steel cabinet, finished with corrosion resistant epoxy paint. Pump module units shall be provided by the ground source, closed loop heat pump manufacturer.

C. Unit Heaters (Electric)

1. Acceptable Manufacturers

- a. Markel
- b. Modine
- c. Chromolox

2. Construction

- a. Heavy gauge die formed steel housing.
- b. Completely enclosed fan motor and motor guard.
- c. Individually adjustable discharge louvers.
- d. Aluminum finned, copper clad steel sheath heating element.
- e. Low voltage controls complete with 24 V control transformer if required.
- f. Automatic reset thermal cutout, capillary type.
- g. Fan time delay at off cycle to dissipate heat from elements.

- h. UL listed.
- i. Disconnect switch, non-fused, interlocking and meeting NEC requirements.
- j. Integral or remote thermostat as indicated.

D. Exhaust Fans

1. In-Line Centrifugal Fans

ANSI/AMCA 210 with AMCA seal. Provide welded steel casings, centrifugal backward inclined blades, direct drive. Inlet and outlet connections for fan casings to ductwork and equipment casings, may be of the slip fit or flanged type. Air shall enter and leave the fan axially. Inlet shall be streamlined. Enclose fan bearings and drive shafts, and isolate from the airstream. Fan bearings shall be mechanically sealed against dust and dirt and shall be self-aligning, pillow block ball or roller type. Motor and drive shall be provided by fan manufacturer. Provide with disconnect, speed controller, backdraft damper, and vibration isolated hanging rod and hardware.

2. Bathroom Exhaust Fans

UL 507 and UL listed for ceiling installation, HVI (Home Ventilating Institute) certified, with AMCA seal.

2.2 ELECTRICAL

A. Electrical Motors, Controllers, Contactors, and Disconnects

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to Division 16 Electrical. Provide electrical connections under Division 16 Electrical. Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

B. Electrical Work

Provide under Division 16 Electrical. Provide control wiring under this section in accordance with NFPA 70.

2.3 METAL DUCT SYSTEMS

Provide shop-fabricated, zinc-coated steel ducts conforming to ASTM A 653/A 653M coating designation G90. Fabricate, construct, brace, reinforce, install, support, and seal ducts and accessories in accordance with SMACNA DCS. Provide rectangular ductwork for low pressure applications; round and flat oval ductwork for medium and high pressure applications as indicated. Cover duct transverse joints with single component synthetic rubber type compound suitable for use with passivated coating on zinc-coated steel. Lap joints in direction of flow. Provide ducts straight and smooth on inside with neatly finished airtight joints. Provide air supply and return openings in ducts with air diffusers, registers, or grilles.

A. Ducts of Pressure Classes Up To 3 Inch WG

Construction, metal gage, hangers and supports, and reinforcements shall conform with SMACNA DCS, except that ducts with pressure classifications below 2 inch water gage that are located outside of the conditioned space shall have a seal Class B. Ductwork shall be airtight and shall not vibrate or pulsate when system is in operation. Pressure sensitive tape shall not be used as a primary sealant on ductwork with pressure classifications above one inch water gage. Air leakage shall be less than 5 percent of the system capacity. Construct ductwork of galvanized steel.

1. Curved Elbows

Make a centerline radius not less than 1 1/2 times the width or diameter of the duct.

2. Laps

Make laps at joints in the direction of airflow. Space button-punch or bolt-connection in standing seams at fixed centers not greater than 6 inches. Longitudinal locks or seams, known as "button-punch snap lock," may be in lieu of Pittsburgh Lock.

3. Fittings

Elbows, vanned elbows, take-offs, branch connections, transitions, splitters, volume dampers, fire dampers, flexible connections, and access doors shall conform with SMACNA DCS, Section 2.

Provide factory fabricated, airtight, and noncorrosive test holes with screw cap and gasket.

B. Flexible Duct Connectors

Provide a minimum of design pressure rated plus 5.0 inch W.G. static pressure airtight flexible duct connectors at duct connections to each air-conditioning unit, air-handling unit, exhaust fan, and ventilating fan. Support connectors at each end with metal angle frame bands, securely bolt in place. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene.

C. Turning Vanes

Provide fabricated tees and square elbows with double walled turning vanes in accordance with SMACNA DCS for vaned elbows.

D. Dampers

Provide factory manufactured opposed blade adjustable manual dampers where indicated for duct heights of 12 inches and larger. Provide factory manufactured single leaf dampers for duct heights less than 12 inches. Provide damper shafts with 2 inch standoffs to clear 2 inches of duct insulation with bearings at both ends of the shafts. Provide adjustment quadrant with indicator and locking devices. Provide galvanized steel dampers 1 gage heavier 10.006 inch than duct in which dampers are installed.

E. Diffusers, Registers, and Grilles

Provide factory-fabricated metal units with edges rolled or rounded where exposed to view, and factory primed with off-white enamel finish. Provide each diffuser and register with factory-fabricated, group-operated, adjustable, opposed-blade, air-volume-control dampers, key or screwdriver operated from the face of unit. Provide each unit with rubber or plastic installation gaskets. Diffusers in same room shall have same face design.

1. Diffusers: Provide round, square, or rectangular diffusers as indicated. Ceiling diffusers shall be designed to deliver air in a horizontal direction. Provide baffles or other devices as required for proper air distribution pattern. Provide 4-way pattern unless otherwise noted on contract drawings.

2. Registers: Provide double deflection supply registers arranged to control air direction, throw, and drop. Exhaust and return air registers shall have single set of nondirectional face bars or vanes having the same appearance as supply registers. Provide face bars or vanes spaced not more than 0.75 inch on center and not less than 0.62 inch depth.
3. Grilles: Provide as specified for registers without air-volume-control dampers.

F. Exhaust Air Louvers

Louvers shall bear AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500 and AMCA 511. Maximum pressure drop shall be 0.1 inch W.G.. Louvers shall have maximum water penetration of 0.20 ounce per square foot of free area at free velocity of 800 fpm. Provide aluminum alloy with anodized finish frames and blades assembled with stainless steel screws, including 0.5 inch mesh aluminum screen mounted in extruded aluminum frame.

G. Access Doors

Provide for access to volume dampers, fire dampers, plenum chambers, and where indicated. Provide each door with double wall zinc-coated steel construction, gasketed airtight, with continuous hinges and cam latches. Insulate access doors with one inch thick rigid insulation. Provide 12 inch by 12 inch door, except where larger sizes are indicated, or provide 12 inches by height of duct when duct is less than 12 inches high. Provide keyed-alike 90 degree turn cam locks on each access door in sleeping rooms; furnish three keys.

H. Fire Dampers

UL 555 and NFPA 90A. Dampers shall be listed in UL BMD. Dampers when open shall not protrude into the ducts. Dampers shall be dynamic rated.

I. Flexible Round Ducts (see Execution section for limitations on use)

UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Fire hazard rating of duct assembly shall not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 2 inches W.G. positive and 1.5 inches W.G. negative. Flexible round duct length shall not exceed 5 feet. Secure

connections by applying adhesive for 2 inches over rigid duct, apply flexible duct 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

1. Inner duct core: Flexible core shall be interlocking spiral or helically corrugated and constructed of zinc-coated steel, aluminum, or stainless steel; or shall be constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.
2. Insulation: Inner duct core shall be insulated with mineral fiber blanket type flexible insulation, minimum of 1 inch thick. Insulation shall be covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

J. Linear Diffusers

Joints between diffuser sections shall appear as hairline cracks. Provide alignment slots for insertion of key strips or other concealed means to align exposed butt edges of diffusers. Equip with plaster frames when mounted in plaster ceiling. Do not use screws and bolts in exposed face of frames or flanges. Frames and flanges exposed below ceiling shall be metal-filled and ground smooth. Furnish separate pivoted or hinged adjustable air-volume-damper and separate air-deflection blades.

2.4 PIPING SYSTEMS

Provide the following pipe and fittings. Provide dielectric fittings, unions or flanges between steel piping and copper tubing for all piping sizes; except that copper alloy valves and strainers may be used without dielectric fittings, unions or flanges. Water piping sizes 4 inches and smaller shall be copper tubing. Water piping sizes larger than 4 inches shall be copper tubing or steel piping.

A. Soldered Joint Copper Tubing

Provide ASTM B 88, Type L or M for aboveground piping, Type K for buried piping, with ANSI B16.18 or ASME/ANSI B16.22 solder joint fittings, unions, and flanges; provide adapters as required. Provide ASTM B 42 copper pipe nipples with threaded end connections. Provide ASTM B 32, 95-5 tin-antimony solder, or provide Plumbing Code approved lead-free solder.

B. Grooved-End Copper Tubing System

Grooved-end copper tubing system may be provided in lieu of soldered joint copper tubing for water piping located within the mechanical equipment rooms and aboveground exterior of the buildings for pipe sizes 2 through 6 inches. Provide grooved-end mechanical couplings of the rigid type including EPDM gaskets and copper fittings supplied by the same manufacturer for pipe sizes 2 through 6 inches.

1. Copper Tubing

ASTM B 88, Type M with rolled grooved end connections.

2. Copper Fittings

Copper alloy shall conform to ASTM B 75 C12200, ASTM B 152 C11000, ANSI B16.18, or ASME/ANSI B16.22 for factory rolled grooved copper alloy tees, elbows, and reducers.

C. Copper Cold Drain Piping

Provide copper tubing in accordance with paragraph entitled "Copper Tubing" for Piping Sizes One Inch and Smaller." Provide ASTM B 306 copper tubing and ANSI B16.23 solder joint fittings for piping sizes larger than one inch. In lieu of copper tubing, 1.25 inch Schedule 40 polyvinyl chloride (PVC) plastic pipe, fittings, and solvent cement may be provided.

D. Ground Heat Exchanger Piping System

Provide polyethylene pipe and fittings for the underground portions of the ground heat exchanger. Use of polyvinyl chloride (PVC) pipe and fittings is not permitted.

1. Polyethylene Pipe: Pipe shall be manufactured from virgin high density polyethylene extrusion material in accordance with ASTM D 2513 with PE345434C or PE355434C cell classification and UV stabilizer of C, D, or E as specified in ASTM D 3350. Provide ASTM D 3035 pipe with a standard dimension ratio (SDR) of 11.0 for pipe less than 1.25 inches diameter. Provide ASTM D 2447, Schedule 40 or ASTM D 3035 pipe with a minimum SDR of 13.5 for pipe 1.25 inches diameter or greater, and a minimum SDR of 17.0 for pipe 3 inches diameter or greater. Provide ASTM D 3035 pipe in vertical bores greater than 200 feet deep with a SDR of 11.0.

2. Fittings: Provide ASTM D 3261 butt and saddle fusion fittings and ASTM D 2683 socket fusion fittings manufactured in accordance with ASTM D 2513. Barbed fittings and hose clamps are not permitted in polyethylene pipe systems.
3. U-bends: Provide factory-fused, injection-molded 180 degree U-bend assemblies equipped with anti-buoyancy devices.

E. Dielectric Connections

Provide at connections between copper and ferrous metal piping materials. ASTM F 441/F 441M, Schedule 80, CPVC threaded pipe nipples, 4 inch minimum length, may be provided for dielectric connections in pipe sizes 2 inches and smaller.

F. Valves

Valves shall have flanged end connections, except valves smaller than 2.5 inches may have threaded end connections with a union on one side of the valve. Solder end connections may be used for connections between copper alloy valves and copper tubing.

1. Gate Valves

MSS SP-80, Class 125, except sizes 2.5 inches and larger shall conform to MSS SP-70, Class 125.

2. Check Valves

MSS SP-80, Class 125, swing check; except sizes 2.5 inches and larger shall conform to MSS SP-71, Class 125.

3. Ball Valves

Full port design, copper alloy body, except sizes 2.5 inches and larger shall be cast-iron body. Valves shall have two-position lever handles. Ball valves may be provided in lieu of gate valves.

4. Air Venting Valves

Provide copper alloy body valves with automatic or manual air vent as indicated.

G. Specialty Valves

1. Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 125 psig at 190 degrees F hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tappings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the gallons per minute flow for each differential pressure reading.

2.5 PIPING ACCESSORIES

A. Pipe Hangers and Supports

Provide MSS SP-58 and MSS SP-69, Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

B. Strainers

Pressure and temperature range shall be for the intended service. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. Provide stainless steel strainer element with perforations of 0.047 inch for water, 0.031 inch for steam mixed with condensate, and 0.016 inch for steam. Provide copper alloy or cast-iron body strainers in steam and condensate systems up to 100 psig. Provide steel body strainers in steam and condensate systems 100 psig and greater.

C. Traps

Provide traps of the types indicated with stainless steel internals. Pressure and temperature range shall be for the intended service. Traps for steam at 100 psig and greater shall be minimum of ASME Class 150.

D. Pressure Gages

Provide single style pressure gage with 4.5-inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubber, and syphon. Provide scale range for intended service.

E. Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors. Provide 1-inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

1. Sleeves in Masonry and Concrete

Provide steel pipe sleeves or Schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2. Sleeves not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

F. Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid where indicated. Connectors shall be suitable for the intended service.

G. Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

H. Tracer Wire

Provide metallic tracer wire for all underground buried piping.

2.6 ACCESS DOORS FOR VALVES

Provide factory-prefabricated and primed flush face steel access doors including steel door frame for with continuous hinges and turn-screw-operated latch. Provide door frame installation in plaster and masonry walls. Furnish doors under this section; install doors under appropriate section of this specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. HVAC System

Installation of HVAC system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ASME B31.1, ASME/ANSI B31.5, NFPA 70, and in accordance with the manufacturer's recommendations.

3.2 PIPING

Test, inspect, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for connections. Make changes in piping sizes through tapered reducing fittings; bushings will not be permitted. Install valves with stems horizontal or above. Provide flanges or unions at valves, traps, strainers, and connections to equipment; unions are not required in copper tubing piping systems.

- A. Threaded connections: Provide Teflon pipe thread paste on male threads. Do not thread metal pipe into plastic piping.
- B. Pipe hangers and supports: Provide additional pipe hangers and supports at in-line water pumps and flanged valves.
- C. Piping to receive insulation: Provide temporary wood spacers between the pipe hangers and supports, and the pipe to properly slope the piping and establish final elevations. Provide temporary wood spacers of same thickness as insulation to be provided under Section 15250, "INSULATION". Support plastic piping every 4 feet. Support metal piping as follows:

MAXIMUM SPACING (FEET)

Nominal Pipe Size (inches)	One and under	1.25	1.5	2	2.5	3	3.5	4	5	6
Copper Tubing	6	7	8	8	9	10	11	12	13	14

- D. Cleaning of piping: Keep interior and ends of new piping and existing piping affected by Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

- E. Tee Joints: Extracted tee joints may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to ensure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints shall not be permitted.

- F. Tracer Wire

 Provide metallic tracer wire for all underground buried piping.

- G. Aboveground Piping

 Provide unions in piping to facilitate removal of heat pump for maintenance or replacement. Test, inspect, and approve piping before covering or concealing. Provide fittings for changes in direction of piping and for connections. Make changes in piping sizes through tapered reducing fittings; bushings will not be permitted. Install valves with stems horizontal or above. Provide flanges or unions at valves, traps, strainers, and connections to equipment; unions are not required in copper tubing piping systems.
 - 1. Pipe Hangers and Supports: Install in accordance with MSS SP-69. Provide additional pipe hangers and supports at in-line water pumps and flanged valves.

2. Piping to Receive Insulation: Provide temporary wood spacers between the pipe hangers and supports, and the pipe to properly slope the piping and establish final elevations. Provide temporary wood spacers of same thickness as insulation to be provided under Section 15250 "Insulation".
3. Cleaning of Piping: Keep interior and ends of new piping and existing piping, affected by Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.
4. Flushing the Aboveground Piping: Before connection of the header to the polyethylene ground heat exchanger loops, flush the entire aboveground piping system thoroughly in accordance with IGSHPA 21020 recommendations and leave filled with clean water. If the header is not immediately joined to the ground heat exchanger loop, the open ends shall be taped or capped.

H. Ground Heat Exchanger Piping

Examine areas and conditions under which ground heat exchanger systems will be installed. Prior to excavation, trenching, or drilling, locate and mark buried utilities. Do not proceed with work until approved by the Contracting Officer. Avoid sharp bends in piping. Provide fittings for changes in direction when minimum bend radius, as recommended by the pipe manufacturer, is exceeded. Use only continuous pipe in sharp bends. Make changes in piping sizes through tapered concentric fittings. Leaks shall be "cut-out" and repaired in accordance with the pipe manufacturer's recommendations. Direct buried threaded connections are not permitted.

1. Vertical Well Fields: Each U-bend loop shall be assembled, laid out straight, taped to reduce springback, and water pressure tested at 100 psi for leaks and flow by IGSHPA 21020 recommended procedures before the hole is bored. Vertical bores shall be 5 feet deeper than the length of the loop and shall be clean (no casing) and of sufficient diameter to facilitate the installation of the U-bend assembly and a third pipe for pressure grouting. Fill the loop with water and pressurize to 40 psi to prevent the pipe from being crushed by backfill material. Backfill the bores from the bottom up with a high solid bentonite grout material and grouting process in conformance with IGSHPA 21010 to ensure pipe contact and compliance with local and State requirements for sealing. Bentonite grout shall be prepared in accordance with

manufacturer's recommendations for water-to-mix ratio. The bores shall not contain large, sharp, or jagged rocks or debris. Take reasonable and prudent care during installation and backfilling to not crush, cut, or kink the pipe.

2. Polyethylene Piping: Install piping in accordance with manufacturer's written instructions. During installation, keep trash, soil, and foreign objects out of the pipe. Tape or cap ends of the pipe until the pipe is joined to the circuit. The vertical loop take-off tee fittings may be made using tee fittings or the saddle fusion process on header piping 1.25 inches diameter and above. Completely remove the cutout on the saddle tees. Use bell reductions at pipe reductions. Use reducing socket tees when fabricating socket type reducing headers. Avoid sharp bends in piping. Consult pipe manufacturer for minimum bend radius. Install elbow fittings at changes in pipe direction that are tighter than the minimum recommended bend radius. Use only continuous pipe in vertical U-bend loops.
3. Heat Fusion Process: Joining shall be either by butt, socket, or saddle (for sidewall applications only) fusion in accordance with the manufacturer's Heat Qualification Guide. Use socket fusion joints for pipe 2 inches diameter and less. Use butt fusion joints for pipe greater than 2 inches diameter. Different plastics or grades of plastic shall not be fused together.
4. Pressurizing: After assembly of the entire ground loop system, fill the system with water and pressure test to 100 psi. Visually inspect welds prior to backfill of the trenches.
5. Pipe Identification: Install metalized (detectable) warning and identification tape above each horizontal pipe run. Install tape a minimum of 6 inches below finish grade. Install mechanical identification of vertical bore holes and connecting headers.
6. Threaded Fittings: Threaded joints shall be sealed with a sealant compatible with the circulating fluid; use of lubricating tape for sealing is not permitted. Do not thread metal pipe into plastic pipe or vice versa. Direct buried threaded joints are not permitted. Use threaded joints above grade, within mechanical spaces, or within valve pits.

I. Flushing Ground Heat Exchanger

Before connection of the plastic ground heat exchanger loops to the header, flush each loop thoroughly in accordance with IGSHPA 21020 recommendations and leave filled with clean water. If the loop is not immediately joined to the header, it shall be taped or capped.

3.3 ADJUSTMENTS

Adjust controls and equipment so as to give satisfactory operation. Adjust entire water temperature control system and place in operation so that water quantities circulated are as indicated. Air duct systems shall be adjusted and balanced so that air quantities at outlets are as indicated and so that distribution from supply outlets is free from drafts and has uniform velocity over the face of each outlet.

3.4 INSTRUCTING OPERATING PERSONNEL

Upon completion of work and at time designated by Owner's Representative, provide services of competent technician for period of not less than one 8-hour working day for instruction of Owner operating personnel in proper operation and maintenance of equipment.

3.5 FIELD QUALITY CONTROL

Upon completion and before final acceptance of work, test each system in service to demonstrate compliance with the contract requirements. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work provided by Contractor and repeat tests. Furnish steam, fuel, water, electricity, instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, ducts, and filters.

A. Flow Test of Ground Heat Exchanger Piping: Before backfilling the trenches, flush and purge systems of air and flow test to ensure all portions of the heat exchanger are properly flowing using the procedures recommended by IGSHPA 21020. Utilize a portable temporary purging unit consisting of the following:

1. High volume, high head purge pump
2. Open reservoir
3. Filter assembly with bypass

4. Flow meter
5. Pressure gage
6. Connecting piping
7. Connecting hoses

Using a purge pump and the procedures recommended by IGSHPA 21020, flush and purge each ground heat exchanger system until free of air, dirt, and debris. A velocity of 2 feet/sec is required in pipe sections to remove the air.

Perform the flushing and purging operation with the water source heat pumps isolated by shutoff valves from the ground heat exchanger system. Allow purge pump to run 15 minutes after the last air bubbles have been removed. After the ground heat exchanger is completely flushed of air and debris, open the isolation valves and permit circulation through the heat pumps until the entire system is flushed and purged.

Utilizing the purging unit and the procedures recommended by IGSHPA 21020, conduct a pressure and flow test on the ground heat exchanger to ensure the system is free of blockage. If the flow test indicates blockage, locate the blockage using the manufacturer's recommendation, remove the blockage, then repeat the purge procedure and conduct the pressure and flow test again until all portions of the system are free flowing. The flow test shall be observed and approved by the Contracting Officer.

Form 1, "Ground Heat Exchanger Inspection and Test Report" located below, shall be completed for each system by the Contractor after completion of the flow before the systems can be backfilled.

FORM 1
GROUND HEAT EXCHANGER (GHX) INSPECTION AND TEST REPORT

NOTE: Use separate form for each GHX loop system.

Building: _____ Inspection Date: _____

Ground Heat Exchanger No. or Description: _____

List the WSHP Unit No.'s served by this GHX: _____

Ground Heat Exchanger Design Water Flow - _____ gpm

Calculated purging flow and press to achieve 2 feet/sec

Purging: Flow _____ gpm Head _____ psi, Duration of test _____ min.

Hydrostatic test pressure _____ psi; Duration _____ min.

Did the system pass the pressure test? _____

Is antifreeze required in system? _____ If yes, was antifreeze measured? _____

Has a dimensioned drawing been prepared, completely and accurately showing the layout of the ground heat exchanger? _____

Does the layout differ substantially from the contract documents? _____

If so is the deviation approved? _____

Depth of installed vertical loops is _____ feet. (Design is _____ feet.)

Depth of horizontal piping is _____ feet. (Design is _____ feet.)

Are the trenches clear of sharp bends, rocks, or other sharp objects that could restrict flow? _____

Are all joints heat fused (butt-, socket-, or saddle-fusion)? _____

Do the joints have the proper amount of roll-out? _____

Has the piping material been cut-out and properly removed from saddle-fusion tees? _____

Was the system backfilled properly with good clean backfill material? _____

Comments: _____

Inspected and approved this _____ date by _____

Title: _____

B. Piping Systems Except for Refrigerant Piping

Before insulating, hydrostatically test each new piping system at not less than 188 psig; except pneumatically test fuel oil storage tank and fuel piping system at not less than 5 psig for tank and 50 psig for piping. Maintain pressure for 2 hours with no leakage or reduction in gage pressure. Obtain approval before applying insulation.

C. Air Ducts

Obtain approval before applying insulation.

1. Connect ceiling supply diffusers to low pressure duct with a maximum of 5 feet of flexible duct. Ensure smooth radius bends with proper support. Other uses of flexible duct are not permitted.

D. Equipment

1. Field Testing

Test each item of equipment in operation for continuous period of not less than 24 hours under every condition of operation in accordance with each equipment manufacturer's recommendation. Verify that the equipment operating parameters are within limits recommended by the manufacturer.

2. Equipment Requiring Field Test Plans

Furnish equipment field test plans developed by each equipment manufacturer detailing recommended field test procedures for each item of equipment. Field test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment will not be acceptable. The Owner's Representative will review and approve the field test plan for each item of equipment prior to commencement of field testing of the equipment.

- a. Equipment items to test: Equipment requiring field test plans are listed in paragraph entitled "Statements."
- b. Coordinated testing: Indicate in each field test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of equipment controls which interlock and interface with

controls factory prewired or external controls for the equipment provided under this section.

- c. Prerequisite testing: Equipment for which performance testing is dependent upon the completion of the work covered by Section 15030, "ADJUSTING, BALANCING AND SYSTEM TESTING" must have that work completed as a prerequisite to testing work under this section. Indicate in each field test plan when such prerequisite work is required.
- d. Test procedure: Indicate in each field test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer. Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures shall be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control. Controllers shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.
- e. Performance variables: Each test plan shall list performance variables that are required to be measured or tested as part of the field test. Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Manufacturer shall furnish with each test procedure a description of acceptable results that have been verified. Manufacturer shall identify the acceptable limits or tolerances within which each tested performance variable shall acceptably operate.
- f. Job specific: Each test plan shall be job specific and shall address the particular item of equipment and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.
- g. Specialized components: Each test plan shall include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3. Equipment Requiring Field Test Reports:
 - a. Equipment items for reports: Equipment requiring field test reports are listed in paragraph entitled "Field Test Reports."
 - b. Manufacturer's recommended test: Conduct the manufacturer's recommend field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field testing.
 - c. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables.
 - d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Owner's Representative in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.
 - e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment shall be reviewed, approved, and signed by the Contractor's test director and the QC manager. The manufacturer's field test representative shall review, approve, and sign the report of the manufacturer's recommended test. Signatures shall be accompanied by the person's name typed.
 - f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests shall be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

END OF SECTION