

ADDENDUM NO. 1

BUNCOMBE COUNTY SCHOOLS
ERWIN HIGH SCHOOL E-WING ROOF REPLACEMENT
ASHEVILLE, NORTH CAROLINA

Cort Architectural Group, P. A.
239 Haywood Street
Asheville, North Carolina 28801

February 13, 2012

ITEMS WHICH AFFECT THE PROVISIONS OF THE CONTRACT ARE AS FOLLOWS:

The following changes, additions and/or clarifications to the Advertisement, Plans and/or Specifications are hereby made a part of the original documents. All Contractors (Bidders) shall acknowledge receipt of this Addendum by notation in the space provided on the Form of Proposal.

- Item 1: Bidders are reminded that a Prebid Conference will be held at 9:00 a.m., February 23, 2012, in the Executive Conference Room of the Buncombe County Board of Education offices, 175 Bingham Road, Asheville NC.
- Item 2: Section 23, Mechanical Specifications, as listed in the Table of Contents was omitted from the Bid Documents. Mechanical Specification Section 23 is included in this addendum.

DIVISION 23 – MECHANICAL SPECIFICATIONS
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END OF ADDENDUM NO. 1

DIVISION 23 – MECHANICAL SPECIFICATIONS

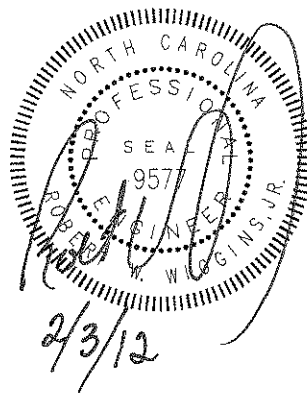
**BUNCOMBE COUNTY SCHOOLS
ERWIN HIGH SCHOOL
E WING ROOF REPLACEMENT
ASHEVILLE, NORTH CAROLINA**

ESE PROJECT NO.: 7393

**ESSENTIAL SYSTEMS ENGINEERING, P. A.
LICENSE NUMBER: C-0516
109 CENTRAL AVENUE
ASHEVILLE, NORTH CAROLINA 28801
(828) 232-1695**

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JANUARY 31, 2012

SECTION 23 00 00

MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. General: This section specifies several categories of provisions of mechanical work, including: 1) Certain adaptive expansions of requirements specified in Division 1, as uniquely applicable to mechanical work, 2) General performance requirements within the mechanical work as a whole and 3) General work to be performed as mechanical work, because of its close association with mechanical work. This section applies to all subsequent Division 23 sections.
- B. Heating, Ventilating, Air Conditioning and Refrigeration work shall include all material and labor to furnish and install all the HVAC systems as indicated on the M-series drawings and the mechanical specifications.
- C. Mechanical Contractor: The Mechanical Contractor shall act as subcontractor and shall be responsible for all aspects of the mechanical work defined in the contract documents and coordinating all efforts with the General and other subcontractors. Refer to General and Supplemental conditions of the contract. References in these documents to the mechanical contractor as a prime or subcontractor shall be superceded by the actual contractual arrangement used on the project.
- D. All start-up and testing and balancing shall be complete. Coordination between the TAB and mechanical contractors will be mandatory and the responsibility of each.

1.2 QUALITY ASSURANCE

- A. Workmen shall be thoroughly experienced and fully capable of installing assigned work. Work shall be in accordance with the best standard practice of the trade. Work that is not of good quality will require removal and reinstallation at no additional expense to Owner and as approved.
- B. Provide complete operational mechanical systems with facilities and services to requirements described, in accordance with applicable codes and statutes.
- C. Drawings are diagrammatic and approximately to scale. The contract documents establish scope, material and quality and are not detailed installation instructions. The Contractor shall be responsible to prepare all necessary coordination and shop drawings to completely and correctly install systems and/or make field modifications necessary resulting from a failure to do so, at no additional cost to the contract
- D. Provide labor and materials required to install, test and place into operation the mechanical systems. Provide additional labor and materials for modifications required to correct job conflicts resulting from a failure to coordinate between trades, at no additional cost to contract.
- E. Certain terms such as "shall, provide, install, complete, start-up" are occasionally not used in some parts of these specifications. This does not indicate that the items shall be less than completely installed or that systems shall be less than complete.
- F. Protect all materials and equipment from damage during storage at the Site and throughout the construction period. In the event of damage prior to final inspections, the Contractor shall repair or replace damaged items as determined by the Architect or Engineer, at no cost to the Owner.
- G. Install all equipment and appurtenances in strict accordance with the manufacturer's recommendations.

- H. Working pressure of piping, fittings, valves, equipment and accessories in piping systems shall be of a pressure rating equal to or greater than the maximum working pressure of the system and/or the test pressure to which it will be subjected.
- I. All welders shall be certified by the Welding Bureau of the Mechanical Contractors Association of America for the appropriate service, and shall perform all welding in accordance with Welding Bureau's procedures and the ASA Code for pipe welding.

1.3 DEFINITIONS:

- A. By other Trades: Shall mean by persons or parties who are not anticipated to be the contractor for this trade working together with the Prime Contractor. In this context the words "by other trades" shall not be interpreted to mean not included in the overall contract, unless specifically noted as not in contract (NIC).
- B. Concealed: Embedded in masonry or other construction, installed behind wall furring, above ceilings, in crawl spaces, in shafts or otherwise not visible.
- C. Contractor: As used in this Division of the specification refers to the Mechanical Contractor unless specifically noted otherwise.
- D. Ductwork: All air distribution, recirculation and exhaust ducts, whether of sheet metal or other material, and includes all connections, hanger, supports, damper controls, insulation, accessories, fire and smoke control devices, and appurtenances necessary for and incidental to a complete system.
- E. Exposed: Not concealed.
- F. Furnish: Purchase and deliver to the project site complete with every necessary appurtenance and for installation.
- G. Install: Unload at the delivery point and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.
- H. Piping: Pipe, fittings, flanges, valves, controls, hangers, supports, traps, drains, gauges, insulation, vents and items customarily required in connection with the transfer of fluids.
- I. Provide: Furnish and install complete ready for use.

1.4 INTERPRETATION OF CONTRACT DOCUMENTS

- A. This section of the specifications and related drawings describe general provisions applicable to every section of Division 23.
- B. Attention is directed to Instructions to Bidders and General Conditions, which are binding in their entirety on this portion of the work and in particular to paragraphs concerning materials, workmanship and substitutions.
- C. Provide all materials called for in these specifications and accompanying drawings and provide the apparatus complete in every respect. Anything called for in the specifications and not shown on the drawings, or shown on the drawings and not called for in the specifications must be provided.
- D. Mention in these specifications, indications and reasonable implications on drawings, whereby articles, materials, operation or methods related to execution of the mechanical work are noted, specified, drawn or described, thereby requires execution of each such item of work and provision of all labor, materials, equipment and appurtenances required for execution thereof.
- E. Particular attention is directed to the drawings and other contract documents for information

- F. Drawings show arrangements of system desired and shall be followed as closely as practical. Because of the small scale of the drawings not all offsets and bends can be shown and these shall be provided as required, to fully complete the intent of plans. Verify and check all measurements in the field. Should conditions and substitutions of equipment necessitate a rearrangement, prepare and submit for review, scaled drawings of such rearrangement before beginning work.
- G. No exclusions from, or limitations in, the language used in the drawings or specifications shall be interpreted as meaning that the appurtenance or accessories necessary to complete any required system or item of equipment are to be omitted.
- H. The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded. When abbreviations appear on the drawings or specification in lower case letter with or without periods, their meanings shall be the same as stated above.
- I. Certain details appear on the drawings that are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not make unnecessary the field coordination for the indicated work.
- J. Information as to the general construction shall be derived from structural and architectural drawings and specifications only.
- K. The use of words in the singular shall be considered as limited where other indications denote that more than one item is referred to.
- L. Submission of a proposal and ultimate acceptance of an agreement or contract for execution of this section of work will be construed as evidence that the Prime Contractor, Subcontractor and Vendor has carefully read and accepts all conditions set forth in each Division under specification Divisions titled "Instruction to Bidders" and Division 1, "General Condition", insofar as such conditions may affect both the bidding for and execution of this section or work.

1.5 DELINEATION OF WORK:

- A. The "Division of Work:" as shown on the drawings, is a recommended division of work as an aid to Contractors and Subcontractors for bidding and performance of the overall prime contract. This or any other reference to the Mechanical Contractor or any Subcontractor shall in no way be intended to interfere with or relieve the Prime Contractor as to his overall responsibility.
- B. Division 23 contractors are required to supply all necessary supervision and coordination of information to any others who are performing work to accommodate Division 23 installations. Where the Division 23 contractors are required to install items which they do not purchase, they shall include for such items:
 - 1. The coordination of their delivery.
 - 2. Their unloading from delivery trucks driven in to any designated point on the property line at grade level.
 - 3. Their safe handling and field storage up to the time of permanent placement in the project.
 - 4. The correction of any damage, defacement or corrosion to which they may have been subjected.
 - 5. Their field assembly and internal connection as may be necessary for their proper operation.

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6. Their mounting in place including the purchase and installation of all dunnage, supporting members, fastenings necessary to adapt them to architectural and structural conditions.
7. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

C. Items that are to be installed but not purchased as part of the work of Division 23 shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the work will be considered only if presented in writing within one week of the date of delivery of the project of the items in question. The work under Division 23 shall include all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.6 MECHANICAL CODES, STANDARDS & REGULATIONS

A. General: All work shall comply with the current governing codes, ordinances and regulations of all National, State and Local authorities having jurisdiction. The requirements of the following governing bodies, codes and standards are included by reference and shall have the same force and affect as if printed here in full (in addition to specific applications specified by individual work sections of these specifications):

1. ADA: Air Diffusion Council.
2. AMCA: Air Moving and Conditioning Association, Inc.
3. ANSI: American National Standards Institute
4. ANSI Pressure Piping Standards (B31-Series).
5. ARI: American Refrigeration Institute
6. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers
7. ASHRAE 15, Safety Code for Mech. Refrig. (ANSI B9.1).
8. ASME: American Society of Mechanical Engineers
9. ASME Boiler and Pressure Vessel Code
10. ASTM: American Society of Testing and Materials
11. AWS Standards for Welding.
12. IBR: Institute of Boiler and Radiator Manufacturers
13. MSS: Manufacturers Standardization Society
14. North Carolina Department of Labor
 - a. The Uniform Boiler and Pressure Vessel Act – current edition
15. North Carolina State Building Code.
 - a. Volume I - General Construction
 - b. Volume II - Plumbing
 - c. Volume III - Mechanical
 - d. Volume X - Energy
 - e. Fire Code
16. NEMA: National Electrical Manufacturer's Association
17. NFPA 45: Standard on Fire Protection for Laboratorial Using Chemicals
18. NFPA 70 National Electrical Code.
19. OSHA: Occupational Safety and Health Administration
20. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc.

B. Include all items of labor and materials required to comply with such standards and codes. Where quantity, sizes or other requirements indicated on the drawings or herein specified are in excess of the standard or code requirements, the specifications or drawings, respectively, shall govern.

C. Should any change in plans or specifications be required to comply with governing regulations, the Contractor is to notify the Professional at the time of submitting his bid.

1.7 PERMITS AND FEES

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- A. The contractor shall arrange for, obtain and pay for all permits, certificates, tests, inspections, agency approvals, etc. and pay all fees levied by the state, local and municipal authorities and having jurisdiction over the work performed under this contract. Provide copies of all required permits, certificates, inspections and agency approvals to the owner. Contractor shall submit to the appropriate Regulatory Agencies all items necessary to obtain all required permits and to perform all tests and inspections.
- B. Contractor shall pay royalties or fees required in connection with the use of any patented devices and systems.

1.8 VERIFICATION OF DIMENSIONS AND LOCATIONS:

- A. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work, working conditions, verify all dimensions in the field, advise the Architect/Engineer of any discrepancy, and submit shop drawings of any significant changes affecting other work he proposes to make, in quadruplicate for approval, before starting the work.
- B. The location of duct, pipe, fixture, equipment and appurtenances for existing facilities are shown on plans to indicate the extent of work required. Exact condition shall be field verified.

1.9 PRODUCT SUBMITTALS:

- A. General: Refer to the Division 1 sections for general requirements concerning work-related submittals. In addition to those general requirements, the following are required for Division 23 submittals. Failure to comply with these requirements may result in rejection without further review.

- 1. Manufacturer or Vendor terms and conditions of sale are strictly between Vendor and Contractor. Approval of submittal data shall not be construed as approval of terms and conditions.

By providing submittals to the contractor to be forwarded to the engineer for review, the equipment vendor is acknowledging review of the contract documents and installation details, and that the submitted product is suitable for application in the manner indicated in the contract documents. Upon request, and at no additional charge, the equipment vendor will provide to the engineer a letter from the manufacturer stating the product has been applied in accordance with manufacturers recommendations.

- B. Product Data, Shop Drawings and Samples: After checking and verifying all field measurements, the Contractor shall submit to the Engineer for review, in accordance with the accepted schedule of shop drawings submissions, copies of all product data, shop drawings and samples, which shall have been checked by and stamped with the approval of the Contractor and identified as the Engineer may require. The data shown on the shop drawings will be complete with respect to dimensions, design criteria, materials of construction and the like to enable the Engineer to review the information as required.

- 1. The Contractor shall review each submittal in detail. The work described in shop drawing submission shall be carefully checked for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with other trades on the job. If it is determined to be correct, the Contractor shall place an approval stamp on each copy; approval stamp shall be filed in with the date on which the items is checked and the checker's name. The Contractor's approval stamp certifies that submittals and related job conditions have been checked and that conflicts do not exist. Any job conflicts arising from the contractor's failure to fully complete these responsibilities shall be corrected as directed by the Professional at no additional cost to the contract. Drawings which the Contractor finds are incomplete or incorrect shall be returned to the source without being forwarded to the Professional. Drawings which do not contain the signed Contractor's stamp may be returned unchecked to the Contractor. Return of unchecked submittals and any delays in construction it may cause, will not be considered cause for any extensions or delays in construction by the

Contractor.

2. Shop drawings shall be submitted well in advance of field requirements to allow ample time for checking. Submittals shall be complete and contain required detailed information. Shop drawings with multiple parts shall be submitted as a package.
3. Include with each submittal a permanent cover sheet for identification. Provide the following information on the cover sheet for proper processing and recording of action taken. A sample cover sheet can be made available by the Engineer for reproduction and use for each submittal.
 - a. Project name;
 - b. name and address of Professional;
 - c. name and address of Contractor;
 - d. name and address of supplier;
 - e. Sequential submittal number (e.g. FP-1, M-1, P-1, P-2, P-3, etc.); resubmittals shall be designated with the same submittal number but noted as a resubmittal (e.g. FP-1R, M-1R, P-1R, P-2R, P-3R, etc.);
 - f. name of manufacturer;
 - g. number and title of appropriate specification section, drawing number identifying symbol, and detail references, as appropriate;
 - h. similar definitive information as necessary.
 - i. space for the Contractor's review and approval markings
 - j. space for the Professional "Action" marking.
4. Submit materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Professional's office. Maintenance and operating manuals are not suitable substitutes for shop drawings.
5. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as special tank linings, pump seals, materials or painting.
6. Include dimensional data for roughing in and installation, technical data sufficient to verify that equipment meets requirements of drawings and specifications. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules.
7. Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Professional.
8. Furnish all submittals for the items used in this project as listed in their related sections.
9. The Contractor shall also submit to the Engineer for review, with such promptness as to cause no delay in work, all samples required by the Contract Documents. All samples shall have been checked by and stamped with the approval of the Contractor, identified clearly as to material, manufacturer, any pertinent catalog numbers and the use for which intended.
10. At the time of each submission, the Contractor shall in writing call the Engineer's attention to any deviations that the shop drawings or sample may have from the requirements of the Contract Documents. Make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.
11. The Engineer shall review with reasonable promptness shop drawings and samples, but his review shall be only for conformance with the design concept of the project and for compliance with the information given in the Contract documents.
12. No work requiring a shop drawing or sample submission shall be commenced until the submission has been reviewed by the Engineer. A copy of each shop drawing and each

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approved sample shall be kept in good order by the Contractor at the site and shall be available to the Engineer and other authorities having jurisdiction.

13. The Engineer's review and acceptance of submitted data or shop drawings for material equipment apparatus, devices, arrangement and layout shall not relieve Contractor from responsibility of furnishing the proper dimensions and weight, capacities, sizes, quantity, quality and installation details to efficiently perform the requirements and intent of the Contract. Approval shall not relieve the Contractor from responsibility for errors, omissions or inadequacies of submitted data or shop drawings.
14. Upon final approval of shop drawings, the Contractor shall submit manufacturer's installation instructions to the Local Building Authority for all equipment and appliances at their request.
15. Upon final approval of shop drawings, the Contractor shall submit a record copy of all applicable items to the Balancing Agency.

1.10 SUBSTITUTIONS

- A. Follow requirements listed in the general provisions of the contract.
- B. Submittals are not opportunities for gaining acceptance of substitutions. Where three or more manufacturers are specified by name or by catalog reference, Contractor shall select for use any of those so specified.
 1. Should Contractor desire to substitute another manufacturer's equipment for one specified by name, the Contractor shall apply to the Engineer in writing no later than the date of the prebid conference for such permission. He shall provide supporting data and samples for Engineers consideration. No substitution shall be made for any material, article or process required under the contract unless approved by the Engineer.
- C. Contract documents are based on materials and equipment specified. Approval by Professional of equipment submitted by the mechanical trade as equal to that specified does not relieve the mechanical trade of any responsibility.
- D. Revisions required to adapt alternative shall be included in such proposals. No increase in the contract price will be considered to accommodate the use of the equipment other than that specified.
- E. Wherever operating results such as quantity delivered, pressure obtained, or similar results are specified, or a definite manufacturer and size of apparatus is specified, for which such quantities are readily determinable, the manufacturer and size of apparatus that the Contractor has proposed using must conform substantially (in regard to the operating results) to the quantities specified or implied. This requirement shall also apply to important dimensions relating to operation of apparatus in coordination with the rest of the system, and to properly locating the apparatus in available space conditions.
- F. Acceptance of substitutions for equipment specified shall be given only after receipt of complete and satisfactory performance data covering the complete range of operating conditions in tabular and graphical form. Furnish complete and satisfactory information relative to equipment dimensions, weight, etc. Acceptance of equipment specified or shown on the Drawings, or substitutions submitted for that specified or shown on the drawings, will be granted if such equipment, in the opinion of the Professional, conforms to the performance requirements, space conditions, weight requirements and quality requirements. Acceptance by the Professional as "equivalent" does not relieve the contractor(s) of any responsibility. Any additional construction and design costs incurred as a result of any accepted substitution shall be borne by the Contractor.

1.11 REQUESTS FOR INFORMATION

- A. During the course of construction, the Contractors may find it necessary to request additional information. The Professional encourages written requests for information (RFI's) to clearly document the request. The response issued by the design Professional is an attempt to assist in the progress of construction. With a response, the design Professional is not conceding any deficiency of the design and is not assuming responsibility for means and methods. RFI's may not be used and asserted as an excuse for late submittal of shop drawings. The Contractor bears the responsibility to prioritize RFI's in the order in which it desires the professional to respond.

1.12 ALTERNATES

- A. Refer to Division 1 for Schedule of Alternates, if any.
- B. Alternate amounts quoted on bid forms shall include any and all costs to coordinate related work among all disciplines and modify surrounding work as required to obtain complete and operational systems.

1.13 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. If conflicts arise, prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Professional before proceeding.

1.14 FUTURE PROVISIONS

- A. Where indicated on the Contract Documents there may be provisions for future work. Contractor shall carefully coordinate any associated work that could effect that future work. Future equipment space and working clearances shall be maintained by avoiding routing current mechanical systems through those areas. Where indications of "Capped For Future" are indicated, provide capped isolation valves in piping and for duct work provide dampers with capped ends, sealed with removable sealant.

1.15 OWNER FURNISHED PRODUCTS

- A. Certain products may be furnished to the site and paid for by Owner. Rough-ins and final connections shall be provided by the HVAC subcontract as required. Contractor shall fully coordinate requirements with Owner and/or Owner's vendor.

PART 2 - PRODUCTS

2.1 MECHANICAL PRODUCT REQUIREMENTS:

- A. Under the Base Bid, the specified equipment shall be used as the basis of the proposal.
- B. Standard Products: Provide not less quality than manufacturer's standard products, as specified by their published product data. Notwithstanding the indication that a particular product/model number is acceptable, comply with the specified requirements. Do not assume that the available off-the-shelf conditions of a product comply with the requirements; as an example, a specific finish or color may be required. Where the specifications do list a specific model number for a manufacturer, the construction of a product shall be equal to those models specifically listed.
- C. Unencumbered Purchases: Wherever possible, avoid the purchase and use of products which are encumbered with questionable title transfers, patent rights, trade union restrictions, code compliance, non-listing as "approved products" for compliance with governing regulations, duties due, embargoes and similar possible encumbrances, claims, or seller's interest.

- D. Purchasing: Do not purchase specific mechanical materials and equipment for the project until completion of submittals that might affect the purchase.
- E. Conditions of Products: Unless noted otherwise, all equipment and materials required for installation under these specifications shall be new and without blemish or defect. Applicable equipment and materials to be listed by Underwriter's Laboratories and manufactured in accordance with ASME, AWWA, or ANSI standards, and as approved by local authorities having jurisdiction. All equipment shall bear labels attesting to Underwriters Laboratories approval where subject to Underwriters Laboratories label service. Where no specific indication as to the type or quality of material or equipment is indicated, a first-class standard article shall be furnished. All manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacturers of said equipment a minimum of three (3) years and, if so directed by the Engineer, be able to furnish proof of their ability to delivery this equipment by submitting affidavits supporting their claim. Comply with Division 1 requirements for exposure or visual display limitations against trademarks and manufacturer's names. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of the product, or required by governing regulations.
- F. Uniformity: Where multiple units of a generic product are required for the mechanical work (as specified in Division 23), provide identical products by the same manufacturer, without variations except for sizes and similar variations as indicated.
- G. Limitations: Product/manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanges and grooved type), insulation, sheet metal, wire, steel bar stock, welding rods, solder, paint, fasteners, motors for unlike equipment units, and similar items used in the work, and except as otherwise indicated.
- H. Product Compatibility Options: Where more than one product selection is specified, either generically, or proprietarily, selection is Purchaser's or Installer's option, except do not provide products which are not compatible with previously purchased or installed products which must interface with the adjacent selections. Provide mechanical adaptations as needed for the interfacing of selected products in the work.
- I. Equipment Nameplates: Provide a permanent operational data nameplate on each item of power operated mechanical equipment, indicating the manufacturer's name and address, product name, model number, serial number, speed, capacity, power characteristics, labels of tested compliance, and similar essential operating data. Locate nameplates in easily-read locations; except where product is visually exposed in occupied areas of the building, locate nameplate in a concealed position (where possible) which is accessible for reading by service personnel. UL or other label, or other data that is die-stamped into the surface of the equipment shall be stamped in a location easily visible. The generic nameplate of a distributing agent will not be acceptable.
- J. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning, testing, charging, lubrication, adjustment, start-up test operation, and shut-down of operating equipment. Provide a copy of such instructions at the equipment during work on the equipment. Consult with manufacturer's technical representatives, who are recognized as the technical experts, for specific instructions on unique project conditions and unforeseen problems.
- K. Statically and dynamically balance rotating equipment for minimum vibration and low operating noise level after installation is complete.
- L. Pressure vessels and relief valves shall be selected, built and labeled in accordance with ASME. Obtain a certificate from the Inspector having jurisdiction showing such acceptance, and mount this certificate in a black frame under glass or laminated plastic adjacent to each pressure vessel and relief valves.
- M. Where factory testing of equipment is required to ascertain performance and attendance by the

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Owner's representative is required to witness such test, associated travel costs and subsistence shall be borne by the Contractor.

- N. No product containing any amount of any form of asbestos shall be installed on this project. Asbestos includes but is not limited to asbestiform varieties of chrysotile, crocidolite, anthophyllite, tremolite or actinolite. The contractor shall furnish a letter to the Owner certifying that this requirement has been complied with prior to final payment.

PART 3 - EXECUTION

3.1 COORDINATION OF MECHANICAL WORK:

- A. The HVAC contractor shall coordinate the HVAC work with the work of other trades to avoid installation conflicts. Conflicts arising from failure to coordinate shall be rectified by the contractors at no additional cost to the contract.
- B. The mechanical drawings show the general arrangement of equipment, ductwork, piping and appurtenances. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories that may be required but not shown on the drawings. Investigate the site, structural and finish ground conditions affecting the work, and arrange the work accordingly. Provide such work and accessories as may be required to meet such conditions.
- C. Examine and compare the contract drawings and specifications with the drawings and specifications of other trades and work furnished by others not in contract (NIC), and report any discrepancies between them to the Professional and obtain from him written instructions for changes necessary in the mechanical work. Install and coordinate the mechanical work in cooperation with other related trades and work furnished by others (NIC). Before installation, make proper provisions to avoid interference.
- D. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale similar to that of the design drawings, prepared on medium of the same size as contract drawings. With these layouts, coordinate the work with the work of other trades. Such detailed work to be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Professional for approval. At completion include a set of such drawings with each set of as-built drawings.
- E. Shut Downs: Any shut down schedules shall be coordinated with the Owner, the department user groups and the other trades involved in the construction. The contractor shall provide a minimum of five (5) days (weekdays) written notice to the Owner's Facility Operations Department and the other trades involved in the construction, whenever a utility outage is required.
- F. Certain materials will be provided by other trades. Coordinate the affected work with other trades. Examine the Contract Documents to ascertain these requirements. Consult with other trades regarding equipment so that, wherever possible, motors, motor controls, pumps and valves are of the same manufacturer.
- G. Wherever work interconnects with work of other trades, coordinate with other trades to insure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (valves, dampers, coils, etc.) requiring access in order that the ceiling trade will know where to install access doors and panels.
- H. Coordination of Options and Substitutions: Where the contract documents permit the selection from several product options, and where it becomes necessary to authorize a substitution, do not proceed with purchasing until coordination of interface requirements has been checked and satisfactorily established.
- I. Chases and Holes: Unless otherwise indicated, all piping and ductwork shall be run in concealed spaces between floor and ceilings or in chases. Ductwork and piping areas without ceilings shall be

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installed exposed and as high as practical. This Contractor shall be responsible for the location and size of holes required for pipe, ducts and other equipment and shall advise of chase spaces and holes required as building progresses. Failure to do so shall require this Contractor to provide or cut same.

- J. Carefully check space requirements with other trades prior to installation to insure that material can be installed in the spaces allotted including finished suspended ceilings.
- K. Structural Limitations: Do not cut structural framing, walls, floors, decks and other members, except with the Architect's or Engineer's written authorization. Authorization will be granted only where there is not another reasonable method of completing the mechanical work, and where the proposed cutting clearly does not materially weaken the structure. Provide required supports and hangers for ductwork, piping and equipment, designed so as not to exceed allowable loading of structures.
- L. Slots, chases, openings and recesses through floors, walls, ceilings, and roofs shall be provided by the various trades in their respective materials. Contractor shall properly locate such openings and be responsible for cutting and patching caused by the failure to do so.
- M. All cutting and patching required for installation of Division 23 work shall be the responsibility of the associated Contractor(s), performed in accordance with all requirements indicated in Division 1.
 - 1. Cutting Concrete: Where authorized, cut openings through concrete (for pipe penetrations and similar services) by core drilling or sawing. Do not cut by hammer driven chisel or drill, unless receiving special permission for specific cases.
 - 2. Other Work: Do not endanger or damage other work through the procedures and processes of cutting to accommodate mechanical work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.
 - 3. Patching: Where patching is required to restore other work, because of either cutting or damage inflicted during the installation of mechanical work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finishes, as judged by the Architect/Engineer and Owner.
- N. Furnish and set sleeves for passage of pipes, ducts and conduits through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each pipe and duct passing through building surfaces. Coordinate locations of sleeves with General Contractor for proper scheduling and installation.
- O. Install mechanical work to permit removal (without damage to other parts) of coils, heat exchanger plates and tube bundles, fan shafts and wheels, filters, belt guards, sheaves and drives, and other parts requiring periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, gauges, starters, motors, and control components, and to clear the opening of swinging doors and access panels.
- P. Sequence, coordinate and integrate the various elements of mechanical work so that the mechanical plant will perform as indicated and be in harmony with other work of the building. The Architect/Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor. Comply with the following requirements:
 - 1. Install piping, ductwork and similar services straight and true, aligned with other work, close to walls and overhead structure (allowing for insulation), concealed where possible in occupied spaces, and out-of-the-way with maximum passageway and headroom remaining in each space.
 - 2. Arrange work to facilitate maintenance and repair or replacement of equipment without removal of relatively fixed building elements or other equipment. Locate services requiring maintenance

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on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.

3. Locate operating and control equipment and devices for easy access. Install access panels where units are concealed by finishes and similar work.
 4. Integrate mechanical work with light fixtures and other work, so that required performances of each will be achieved.
 5. Adjust location of pipes, ducts, panels, equipment, etc., to accommodate the work to prevent interference, both anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication
 6. Right-of-Way: Piping systems that pitch have the right-of-way over those which do not pitch (e.g. drainage systems normally have right-of-way). Service lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 7. Make offsets, transitions and changes in direction in pipes and ducts as required to maintain proper head room and pitch on sloping lines. Furnish and install air vents, drains, etc., as required to effect these offsets, transitions and changes in direction.
 8. Obtain from Others furnishing products, materials or services not in contract, all necessary catalog cut sheets, rough-in requirements or any other such information as required to fully coordinate the services to support all such work by others. Costs that arise from not performing this coordination shall be borne by the Contractor.
- Q. Protective Drip Pans: Where indicated, and where mechanical work piping carrying liquids pass over electrical or electronic equipment which might be damaged by dripping liquids (leakage or condensation), install drip pans 2" deep, 16 gauge copper with rolled edges of adequate width and length to protect the electrical equipment. Pipe drainage from pan to nearest floor drain or similar suitable point of discharge, and terminate pipe as an open-sight drainage connection. Provide permanent support and anchorage to prevent displacement of drip pans. Drains shall be 3/4" copper unless noted otherwise. Locate drip pans as close to underside of piping as possible. Extend edges not less than 6" each side of piping and extend ends not less than 18" beyond equipment being protected.
- R. Electrical Work: Coordinate the mechanical work with electrical work, and interface properly with electrical service to mechanical equipment. In general, and except as otherwise indicated, install mechanical equipment ready for electrical connection.
1. Refer to Division 26 sections for electrical power connection of mechanical equipment, including disconnect switches.
 2. Power Characteristics: Refer to the appropriate sections of Division 26 and the electrical drawings for the power characteristics available for the operation of each power driven item of mechanical equipment. Coordinate purchases to ensure uniform interface with electrical work.
- S. Utility Coordination: Coordinate the connection of mechanical systems with exterior underground and overhead utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies. It is the construction contractor's responsibility to mark and trace the lines using appropriate/suitable devices; i.e., metal detectors, pipe locators, etc.; or by having the appropriate utility company stake the lines. The contractor shall repair all utility systems he damages at no charge to the Owner. All repairs shall be performed to Owner's or the affected utilities' satisfaction. The contractor is responsible for all utility hook ups, disconnects and coordination with the appropriate agencies.
- T. Seasonal Requirements: Adjust and coordinate the timing of mechanical system start-ups with seasonal variations, so that demonstration and testing of specified performance can be observed and

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recorded. Exercise proper care in off-season start-ups, to ensure that systems and equipment will not be damaged by the operation.

- U. The HVAC Contractor shall be responsible to coordinate their work with the TAB and commissioning Agencies and notify the Agencies when each phase of the project is at 30, 60 and 90 percent complete, in order for the Agencies to provide the required field inspections.
- V. The HVAC Contractor shall be responsible for ensuring that the HVAC systems, wiring, and controls are complete and operational and for providing written documentation as such to the Professional and the TAB and commissioning Agencies prior to TAB and commissioning services being performed. The HVAC Contractor shall be responsible for any costs associated with additional services required to reschedule and/or redo TAB or commissioning Services and punch list inspections resulting from the failure to perform said completed services.
- W. Painting and Air Distribution: Coordinate with initial cleaning and start-up of HVAC air distribution system, to occur prior to preparatory cleaning and general interior painting and decorating on the project.

3.2 CUTTING & PATCHING:

- A. See Division 1 for Cutting and Patching requirements.
- B. This Contractor must have an experienced Mechanic on the job before concrete floors, concrete or masonry walls are set in place, whose duty it shall be to locate the exact position of any and all sleeves and holes for the future installation of his pipe or duct work. This Contractor shall locate and size all openings required for his equipment in time to not delay the building construction.
- C. If it becomes necessary to cut holes in concrete floors or concrete or other masonry walls, each subcontractor shall call the Prime Contractor or his superintendent of Construction, and inform him of the position and size of the hole or other opening to be provided and the Prime Contractor shall determine how this will be done. Under no condition shall this Contractor make any cuts without permission from the Prime Contractor, nor shall he cut any green floors or walls.
- D. This Contractor shall arrange proper openings in the building to admit his equipment. If it becomes necessary to cut any portion of the building to admit any equipment or install mechanical systems, this Contractor shall be responsible for cutting and patching. The portions cut must be restored to their former condition by this Contractor.
- E. All cutting of structure shall be done using best method to minimize noise and cracking of structure. The method of cutting shall be approved by the Prime Contractor before work if started.
- F. All drilled holes required for equipment or supports shall be done by this Contractor. Holes for piping shall be core drilled only.

3.3 STORAGE AND INSTALLATION OF EQUIPMENT AND MATERIALS:

- A. Move and store products and materials in a manner that will protect them from damage, weather and entry of debris. The Contractor shall fully protect finished parts of the materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Materials and equipment in storage and during construction shall be stored on elevated supports and covered on all sides with securely fastened protective rigid or flexible waterproof coverings in such a manner that nothing will be damaged or marred, and kept clean and dry. If items are damaged, do not install, but take immediate steps to obtain replacement or repair at no cost to Owner.
- B. Piping shall be protected by storing it on elevated supports and capping the ends with suitable closure material to prevent dirt accumulation in the piping.
- C. During construction cap all ductwork openings that could be exposed to dust, dirt and debris. Cap all

- D. Periodically during construction and prior to Owner acceptance of the building, Contractor shall remove from the premises and dispose of all packing material and debris. All adjacent occupied areas shall be cleaned daily to remove dirt and debris resulting from this work.
- E. If products and materials are specified or indicated on the drawings for a specific item or system, the Contractor shall use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of shop drawings.
- F. Install materials and equipment with qualified trades people. Install all equipment and appurtenances in strict accordance with the manufacturer's instructions and recommendations.
- G. Replace materials less than specified quality or as designated by Professional and relocate work incorrectly installed as determined by Professional.
- H. Do not operate air systems until ductwork is complete, temporary filters are in place and construction debris is removed. Provide one-inch thick fiberglass filter media across the face of each return air opening prior to start of each air system during temporary system operation. HVAC Contractor shall bear the responsibility to thoroughly clean all air handling equipment, interior surfaces of ductwork, terminal devices, air distribution devices and any other related mechanical equipment if permanent systems are ever used for temporary heat.
- I. Do not operate water systems until piping has been cleaned and startup strainers are in place.
- J. Secure equipment with bolts, washers and locknuts of ample size to support equipment. Embedded anchor bolts to have bottom plate and pipe sleeves. Grout all machinery set in concrete under the entire bearing surface. After grout has set, remove all wedges, shims and jack bolts and fill space with grout.
- K. Valves, dampers operators, and access doors, shall be easily accessible, either in mechanical spaces or through access panels specified.
- L. All equipment shall be thoroughly cleaned. All excess materials and all debris shall be removed from the site.

3.4 REVIEW OF WORK PROGRESS:

- A. Prior to performing work, the Contractor shall carefully review and assess the installed Work of all other Trades and verify that all such Work is complete to the point where his installation may properly commence.
- B. Verify that all equipment may be installed in accordance with all pertinent codes and regulations, the original design and the referenced standards. Schedule and obtain inspections of the AHJ, and contact Professional for site observations at appropriate times.
- C. In the event of discrepancy, immediately notify the Architect/Engineer.
- D. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.

3.5 WELDING:

- A. All welded piping shall be installed by Contractor using NCPWB or ASME Certified Welding Procedures. Welding shall comply with ANSI/ASME B31.1 and Section IX of the ASME Boiler and Pressure Code.

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- B. All welded piping shall be hydrostatically tested for pressure of 1-1/2 times the working pressure of the line, but not less than 150 psig. This hydrostatic test shall be witnessed by the Engineer.
- C. Ten days before any welded work is to start, the Contractor shall furnish the Engineer copies of the welding procedures approved for the Contractor.
- D. Before any welder is put to work in welding any piping for this job, the Engineer shall be furnished with duplicate copies of the certification of each welder. If, in the opinion of the Engineer, the welding is not done properly, a coupon shall be cut from field welds for inspection and/or the welder may be required to pass a recertification test. Costs of cutting the coupon shall be the responsibility of the Contractor. Also all welds shall be subject to non-destructive x-ray examination by Owner. In the event that defective work is found the Contractor will be responsible for all costs of non-destructive x-ray examination, including all remedial repair work and retesting of welding that is determined to be unsatisfactory.
- E. No welding is to be covered with insulation or concealed until the welding has been approved by the Engineer as outlined above.
- F. All welding operations shall be approved by the Engineer prior to beginning work. Extreme care shall be exercised to prevent damage to the existing buildings or building or surrounding contents during welding operations.
- G. During welding of all piping, contractor shall use fire resistant or equal pad protection to prevent scorching or burning of existing floor and wall finishes, etc. Also, care shall be taken to eliminate sparks from dropping on existing furniture, equipment and flooring material. All damages created by welding flame or sparks shall be repaired to owner's satisfaction at contractor's expense.

3.6 PAINTING REQUIREMENTS:

- A. Work buried in soil or encased in concrete or insulation need not be painted (except for protective coatings specified with the piping system).
- B. Painting of work in finished areas will be done by others. However, this Contractor shall leave his work in proper condition and ready for painting by removing all dirt, grease, pipe dope and scale or other foreign material by wire-brushing or as required.
- C. Before insulating, all black steel piping in equipment rooms shall be given one (1) heavy coat of Sherwin-Williams B-68-AZ, Rustoleum or Koppers black stack paint. Miscellaneous metal in unfinished areas and in the equipment rooms shall be given two (2) coats of Sherwin-Williams, Rustoleum, Koppers or equal "B" asphaltum.
- D. All insulation of piping and ductwork/insulation in equipment rooms shall be painted. After sizing pipe and insulation, it shall be painted with two (2) coats of chlorinated rubber base paint or other material as approved by the Architect. Exterior metal shall have two (2) coats of protective finish paint.
- E. Except as indicated specifically otherwise herein, paint material shall be selected from materials for work under the Architectural Specifications.
- F. Painting on all pipe and pipe insulation in equipment rooms shall be done by the Mechanical Contractor. Colors shall be selected from the Industry Standard for colors or those approved by the owner.
- G. All equipment having factory applied finish shall have its surface restored to its original condition if the finish is marred during installation.
- H. All exposed pipe and equipment in the equipment rooms which do not have factory finish, shall be painted two (2) coats of enamel, using material approved for work under the Architectural Specifications.

- I. Paint flat black inside of ductwork, where it can be seen from occupied spaces through grilles or louvers (under any lighting condition). Galvanized steel shall be painted with two (2) coats of Derusto Gal-va-grip (or equal) before final coat of paint is applied.
- J. Paint accessible ferrous metal (does not include stainless steel), regardless of whether exposed or to be concealed behind ceilings, shaft enclosures or similar finish construction; exclusive of cast iron which is either concealed or set flush with floors or decks.

3.7 MANUALS, REPORTS AND FORMS SUBMITTAL:

- A. Submit specified number of operating and maintenance manuals, reports and forms (minimum of three) to the A/E for review. Submittals shall be in strict compliance with specifications.
- B. Submittals not approved or not submitted in proper format may be rejected and returned to Contractor. Contractor shall make necessary changes and resubmit until approved.
- C. Submittals shall include all reports, forms and manuals referenced in these specifications.

3.8 GENERAL COMPLETION AND DEMONSTRATION:

- A. All aspects of the work shall be completed and demonstrated to be operating correctly before project will be considered complete. The following results are expected:
 - 1. All systems and controls shall be complete, tested and operational.
 - 2. All start-up and testing and balancing shall be complete.
 - 3. All equipment shall be thoroughly cleaned. All excess materials and all debris shall be removed from the site.
 - 4. All walls, floors, ceilings and other surfaces marred or otherwise damaged as a result of execution of this contract shall be cleaned and repaired to the satisfaction of the Architect/Engineer and Owner.

3.9 MAINTENANCE OF LOCAL SERVICE ORGANIZATION:

- A. The Contractor shall maintain sufficient forces to respond promptly to any system problems that occur during construction and during the warranty period. The Contractor shall provide the Owner and the Engineer with reliable and prompt means of contacting the Contractor. In the event that after an attempt to contact the Contractor, the Contractor does not respond appropriately to any problem, the Owner and/or Engineer will without further notice address the problem. All costs associated with addressing the problem will be borne by the Contractor including all risk of damage to equipment except that caused by gross negligence of others.

END OF SECTION

SECTION 23 05 29

HANGERS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This section specifies hangers, supports and anchors for use in piping systems specified in other sections of these specifications.

PART 2 - PRODUCTS

2.1 HORIZONTAL PIPING HANGERS AND SUPPORTS:

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information; size hangers and supports properly for piping, including insulation (if any).
- B. Adjustable Clevis Hanger: MSS Type 1, fabricated from steel.
- C. Adjustable Band Hanger: MSS Type 7, fabricated from steel.
- D. Clamp: MSS Type 4.
- E. Double-Bolt Clamp: Welded structural steel shapes complying with one of the following:
 - 1. Medium Duty: MSS Type 32.

2.2 VERTICAL PIPING CLAMPS:

- A. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection as determined by the Installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size clamps properly for piping, including insulation (if any).
- B. Two-Bolt Riser Clamp: MSS Type 8.

2.3 HANGER-ROD ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size attachments properly for piping, including insulation (if any).
- B. Turnbuckles: MSS Type 13.
- C. Weldless Eye-Nut: MSS Type 17.
- D. Malleable Eye-Socket: MSS Type 16.
- E. Clevises: MSS Type 14.

2.4 BUILDING ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory-fabricated building attachments of the MSS type and load-rating indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or load-rating is not indicated, provide proper selection MSS SP-69 and the manufacturer's published product information. Size units properly for the piping loading.
- B. C-Clamps: MSS Type 23, malleable iron.
- C. Beam Clamp/Extension Piece: MSS Type 30.

2.5 SADDLES AND SHIELDS:

- A. General: Except as otherwise indicated, provide factory-fabricated saddles and shields of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size saddles and shields properly for insulation and vapor barrier (if any). Saddles are required at each hanger supporting insulated piping.
- B. Protection Shields: MSS Type 40.

2.6 EQUIPMENT STANDS, FOUNDATIONS AND MISCELLANEOUS STEEL FOR HANGERS AND SUPPORTS:

- A. Provide all equipment stands and supports for equipment as shown or required. Provide miscellaneous steel for hanging piping, ducts or other items of equipment as shown as required.
 - 1. Metal Framing: Provide products complying with NEMA STD ML 1.
 - 2. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
- B. All concrete foundations, curbs and pads for equipment, ductwork, piping, etc. shall be provided by this Contractor, unless otherwise indicated. Pads shall be provided for all floor standing equipment.
- C. All stands shall be adequately cross-braced to provide rigid supporting foundation. All stands shall be adequately anchored to wall or floor as required. All miscellaneous steel shall have one coat of shop paint and two finished coats of rust resistant paint.

2.7 MATERIALS OF CONCRETE WORK:

- A. Concrete Materials:
 - 1. Portland Cement: ANSI/ASTM C 150, type, except as otherwise indicated.
 - 2. Water: Clean and free of substances harmful to concrete. Calcium Chloride: Use not permitted.
 - 3. Mix for Patching: Where mechanical work requires patching of exposed concrete work which has been cut to accommodate mechanical work, provide concrete patching mix which is identical with mix of work being patched (same cement, aggregates, admixtures and proportioning).

PART 3 - EXECUTION

3.1 PREPARATION:

- A. Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors and associated work, the Installer shall meet at the

project site with the Contractor, the installer of each component of the associated work, the inspection and testing agency representatives (if any), installers of other work requiring coordination with the work of this section and the Architect/Engineer for the purpose of reviewing the material selections and procedures to be followed in performing the work in compliance with the requirements specified.

3.2 INSTALLATION OF BUILDING ATTACHMENTS:

- A. Install building attachments at the required locations onto structural steel for proper piping support. Space attachments within the maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges and at changes in direction of piping.

3.3 INSTALLATION OF HANGERS AND SUPPORTS:

- A. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
- C. Prevent electrolysis in the support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
- D. Provision for Movement: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
- E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.
- G. Install supports to provide minimum 1/2 inch space between finished covering and adjacent work.
- H. Place supports within 12 inches of each horizontal elbow.
- I. Use supports with 1-1/2 inch minimum vertical adjustment.
- J. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze supports.
- K. Support riser piping independently of connected horizontal piping.
- L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields.

3.4 ADJUSTMENT OF HANGERS AND SUPPORTS:

- A. Adjust hangers and supports to bring piping to proper levels and elevations.

3.5 FORMWORK:

- A. *General:* Design, construct and maintain formwork to support vertical and lateral loads including pressure of cast-in-place concrete. Construct formwork so that formed concrete will be required size and shape and in required location. Construct with joints which will not leak cement paste. Form side and bottoms of concrete work, except where clearly indicated to be cast directly in excavation or against other construction, or on grade or prepared subgrade. Design and construct forms for easy removal without damage to concrete and other work.
- B. *Form Coating:* Coat concrete-contact surfaces of forms to be removed. Apply form-coating compound before reinforcement is placed. Apply in accordance with manufacturer's instructions and remove excess compound and spillage.
- C. Deposit concrete continuously or in layers of thickness which will result in no concrete being placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable in its final location, so as to avoid segregation due to rehandling or flowing.
- D. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures complying with recommended practices of ACI 309; eliminate voids in work.
- E. Bring horizontal surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps and hollows.

END OF SECTION

SECTION 23 05 48

SEISMIC RESTRAINTS & WIND RESTRAINTS

PART 1 - GENERAL

1.1 SCOPE

- A. No mechanical equipment and system components in this project require seismic restraint per section 1613, Volume 1, North Carolina Building Code.
- B. Wind restraint is required for all rooftop components per Section 1609, Volume 1, North Carolina Building Code.
- C. The scope of this specification encompasses the necessary product specifications for wind restraints.

1.2 REQUIREMENTS

A. Responsibilities

- 1. The Contractor shall cause all wind restraint systems to be designed by a Manufacturer experienced in this type of work. This provision, however, shall not be construed as relieving the Contractor of his overall responsibility for the work.
- 2. The Contractor shall provide to the manufacturer of wind restraint systems a listing of all mechanical equipment and components to be restrained, including areas, total weight, center-of-gravity and all other data required by them.

B. Design – Wind Restraint Systems

The wind requirements for mechanical equipment and components for this project for all components and systems shall comply with section 1609 of the North Carolina Building Code.

1.3 WIND CERTIFICATION

A. Wind Certification and Analysis:

- 1. Wind restraint requirements, calculations and Design shall be provided for all Mechanical equipment and components. Calculations shall be performed registered professional engineer in the State of North Carolina.
- 2. Calculations to support wind restraint designs must be stamped by a registered professional engineer in the State of North Carolina.
- 3. A wind design Errors and Omissions insurance certificate must accompany submittals prepared by a licensed independent Consulting Engineer in the state of North Carolina.
- 4. The licensed professional engineer responsible for the design of the restraints shall review the restraint installation, and a sealed certificate of compliance shall be issued.

1.4 CODE AND STANDARDS REQUIREMENTS

- A. Applicable Codes
 - 1. International Building Code as adopted by the state of North Carolina with Amendments.
 - 2. SMACNA Guidelines for wind restraint of HVAC systems.
 - B. Where conflicts between these documents exist, the more stringent requirement shall apply.
- 1.5 MANUFACTURER'S RESPONSIBILITY
- A. Manufacturer of restraint equipment shall have the following responsibilities:
 - 1. Determine restraint sizes and locations.
 - 2. Provide equipment and component restraints as scheduled or specified.
 - 3. Provide installation instructions, drawings and field supervision to the contractor to insure proper installation and performance of systems.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. All restraint devices described in this section shall be products of a single manufacturer.

PART 3 - EXECUTION

3.1 General

- A. All restraint systems must be installed in strict accordance with the manufacturers written instructions.
- B. Installation of restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration control integrity.
- D. The contractor shall not install any rotating equipment which makes rigid connection to the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.
- F. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.
- G. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval.

END OF SECTION

SECTION 23 05 99

MECHANICAL DEMOLITION

PART - 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Contractor shall examine the existing buildings, the drawings and these specifications with their provisions regarding the removal of existing items and work. It is not the intent herein to fully describe all the items and work to be removed, demolished, cut, patched, or altered under this section. The Contractor shall assure himself that all of the work required to be removed, demolished, cut, patched or altered for the full completion of the project shall be included at no additional cost to the Owner.
- B. Scope: Without limiting the volume of work and strictly for the Contractor's convenience demolition includes but is not necessarily limited to the removal and subsequent offsite disposal of the following:
 - 1. General Construction: Portions of walls, floors and roofing indicated on drawings and as required to accommodate new HVAC construction.
 - 2. HVAC Construction: Removal of indicated existing equipment, ductwork, piping and controls.

PART - 2 PRODUCTS (NOT APPLICABLE)

PART - 3 EXECUTION

3.1 INSPECTION

- A. Prior to commencement of demolition work, inspect areas in which work will be performed. Photograph existing conditions to structure surfaces, equipment or to surrounding properties which could be misconstrued as damage resulting from demolition work; file with Owner's Representative prior to starting work.

3.2 PREPARATION

- A. Locate, identify, stub off and disconnect utility services that no longer in service and are not indicated to remain.
- B. Provide by-pass connections as necessary to maintain continuity of service to occupied areas of building. Provide minimum of 72 hours advance notice to Owner if shut-down of service is necessary during change-over.

3.3 DEMOLITION

- A. Perform demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations. Refer to the drawings for any defined construction phasing plan. The contractors are required to perform their demolition and/or temporary service tie-in installations in accordance with the progress of the project with minimum disruption to areas outside the construction boundary.
- B. In areas where existing surfaces and structures are to remain, all mechanical equipment and materials designated for removal shall be disassembled where possible and neatly cut where necessary to avoid damaging surfaces and structures. Where damage to existing surfaces and structures occur, the contractor shall be responsible for repairs using proper materials as specified in other sections of this specification and as directed by the Architect.

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- C. All demolished materials and equipment not designated to be turned over to the Owner or retained for reuse shall become the property of the Contractor. The contractor shall legally dispose of these materials and equipment in accordance with the applicable requirements of local, state and federal authorities having jurisdiction. All equipment to be reused is to be cleaned and repaired to like new condition prior to re-installation.
- D. Removals shall be complete and shall include all attachments, brackets, hangers, clamps, hardware, bolts, and screws. Cast in place and expanded anchors do not need to be removed where they are flush with the surface, but protruding studs shall be cut off flush.
- E. Where removals disrupt service to existing piping and equipment which is to remain, the Contractor shall restore service to the remaining equipment and outlets using the construction methods and materials permitted or required by the appropriate sections of this specification.

3.4 ITEMS TO REMAIN PROPERTY OF OWNER

- A. All items as noted on drawings shall be carefully removed, protected, and turned over to the Owner in the condition which existed prior to their removal. The Contractor shall transport the salvaged items with his own manpower and vehicles to a stored location, on site or at the remote warehouse on Riverside Drive designated by the Owner.
- B. The Owner may mark items on site for field salvage which are not designated on drawings. Cooperate with Owner to salvage these items. Transportation off site will be by Owner.

3.5 COORDINATION WITH ASBESTOS ABATEMENT

- A. Asbestos abatement is not anticipate and is not covered by this specification.
- B. Notwithstanding prior completion of asbestos abatement, if any material is encountered which the contractor believes may be hazardous immediately stop work, secure the area and notify General Contractor and Owner's Representative.

3.6 ITEMS TO BE REUSED

- A. All items noted to be reused are to be repaired and cleaned to like new condition prior to re-installation. The items are to be carefully stored by the contractor until they are needed.

END OF SECTION

SECTION 23 07 00

MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to the piping, equipment, and duct systems indicated on the Drawings and specified herein.
- B. Types of mechanical insulation specified in this section include the following for piping, ductwork and equipment:
 - 1. Extruded polystyrene.
 - 2. Rigid Polyisocyanurate.
 - 3. Flexible Unicellular.

1.2 QUALITY ASSURANCE

- A. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings and specifications by skilled workers who have at least five years of successful experience in commercial insulation work.
- B. All insulation work shall comply with the following codes and standards:
 - 1. Certify that all insulation meets the minimum requirements of the current State Energy Code for New Building Construction.
 - 2. NAIMA Insulation Standards
 - 3. ASTM E-84
 - 4. NFPA 255
 - 5. UL 723
 - 6. NFPA 90A
 - 7. NFPA96
- C. Thermal insulation materials shall meet the property requirements of the following specifications as applicable to the specific product or use:
 - 1. American Society for Testing of Materials Specifications:
 - a) ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - b) ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"
 - c) ASTM C-591, "Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation"
 - d) ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - e) ASTM C 1136, "Standard Specification for Barrier Material, Vapor", Type 1 or 2 (jacket only)
 - f) ASTM D1667 - Standard Specification for Flexible Cellular Materials--Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).

- g) ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

D. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 method.

- 1. Exception: Mechanical insulation in mechanical room may have flame spread index of 75 and smoke developed index of 450.
- 2. Insulation jacket for duct, pipe, and equipment exposed to weather to be certified as self-extinguishing in less than 53 seconds when tested in accordance with ASTM D1692.

E. Insulation exposed to view shall have a well-tailored appearance.

1.3 REFERENCE STANDARDS:

A. The following industry standards form a part of these specifications by mention herein.

- 1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- 2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]).
- 3. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
- 4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- 5. ASTM C240 - Standard Test Methods of Testing Cellular Glass Insulation Block.
- 6. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- 7. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- 8. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- 9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- 10. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- 11. NAIMA National Insulation Standards.
- 12. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- 13. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 DEFINITIONS

- A. Thermal resistance "R" values are expressed in units of "Hour-Degrees F-sq. ft./Btu per inch of Thickness" on a flat surface at a mean temperature of 75 degrees F unless noted otherwise.
- B. Thermal conductivity (K), the reciprocal of "R", $\text{btu/hr/f}^2/\text{degree}$.
- C. Insulation to consist of insulating material, jacket, mastic, and adhesive, either as a "system" or as an individual component when used separately.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.6 DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

PART 2 - PRODUCTS

2.1 PIPING INSULATION MATERIALS

- A. General: Molded pipe insulation shall be manufactured to meet ASTM C 585 for sizes required in the particular system. It shall be of a type suitable for installation on piping systems, including fittings and valves. Fitting insulation to be of same thickness and material as adjoining pipe insulation.
- B. TYPE D - RIGID POLYISOCYANURATE FOAM:
 - 1. Rigid closed-cell polyisocyanurate thermal insulation bunstock, fabricated into shapes required to insulate pipe, valves, fittings, vessels, and /or special shapes. Installation of insulation shall be in strict accordance with manufacturer's published guidelines.
 - 2. Polyiso material shall not be produced with, or contain, any of the United States EPA regulated CFC compounds listed in the Montreal Protocol of the United Nations Environmental Program. Insulation shall meet the requirements of ASTM C-591, type I Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 - 3. Product shall meet 75/450 flame-smoke spread rating.
 - 4. "K" value: 0.19 BTU-in/hr-ft² - °F at 75°F and 180 days aging.
 - 5. Minimum service temperature: -320 degrees F.
 - 6. Maximum service temperature: 300degrees F.
 - 7. Density: not less than 2.0 pounds per cubic foot.
 - 8. Water absorption based on 96 hr immersion test shall be no more than 2% by volume.
 - 9. Water vapor permeability shall be no more than 4 perm-inch.
 - 10. Connection: Waterproof vapor barrier adhesive.
 - 11. Subject to compliance with requirements, acceptable manufacturers include:
 - a) Dow "TRYMER 2000" with Saran" vapor retarder film jacketing and tape.
 - b) Dyplast Products, dP-ISO"
 - c) EXTOL, "HiTherm HT-300"
 - d) Cover pipe, valves and fitting insulation with the following finishes: Straight pipe – All service jacket with self-seal lap; valves and fittings – preformed aluminum jacketing, 0.020 inch thick.
- C. Jackets for Piping Insulation:
 - 1. Provide Manufacturer's standard white craft jacket unless indicated elsewhere in this specification.
 - a) Shall comply with requirements of ASTM C 921.
 - b) Use vapor barrier type for piping with temperatures below ambient, vapor permeable type allowable for piping with temperatures above ambient or where closed-cell, non-permeable insulation is used. Vapor barrier type may be used for all piping at installers option.

- c) Provide aluminum jackets in addition to white kraft or canvas jacket for all exterior applications.
 - d) White craft or canvas jackets are not required for insulation type E.
2. Canvas Jacket: UL listed. Fabric: ASTM C921, 6 oz/sq yd, plain weave cotton treated with dilute fire retardant lagging adhesive.
3. Aluminum Jacket: ASTM B209 or ASTM B209M.
- a) Thickness: 0.020 inch.
 - b) Finish: Embossed.
 - c) Joining: Longitudinal slip joints and 2 inch.
 - d) Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
 - e) Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 thick stainless steel.
 - f) Subject to compliance with requirements, acceptable manufacturers include: Proto, Ceel-Co, Pabco, RPR Products, Childers.
- D. Staples, Bands, Wires: As recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, Cement and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
1. Subject to compliance with requirements, acceptable manufacturers include: Foster, Childers, 3M, Marathon, Pittsburgh Corning, Vimasco.

2.2 MATERIALS FOR FITTINGS AND VALVES

- A. Provide factory pre-molded one-piece aluminum fitting covers, insulation inserts of the same material and thickness as adjacent piping insulation (not less than 3 sections per 90 degree elbow) and installation materials for the following services:
- 1. All pipe fittings and valves.
 - 2. Hot surfaces; apply with stainless steel tacks or staples or draw bands.
 - 3. Cold surface; use 2" wide, 10 mil vapor barrier tape furnished by manufacturer of jacket or vapor barrier mastic and drawbands. Do not puncture vapor barrier with tacks or staples.

2.3 DUCTWORK INSULATION MATERIALS

- A. General: Ductwork shall be insulated with expanded polystyrene boards. The insulation shall be selected to conform readily to the surface to which it will be applied. Observe manufacturer's recommendations on maximum temperature/thickness combinations. Before installing insulation, inspect to make sure that all seams and joints in the ductwork have been sealed by the responsible contractor.
- B. Extruded polystyrene board: For outdoor applications on rectangular ductwork provide expanded polystyrene insulation in board form, meeting the requirements of ASTM C 578. Minimum aged R value shall be 5.0 per inch at 75F. Minimum compressive strength shall be 18 per ASTM D1621. Water vapor transmission shall be maximum 1.5 perm per inch per ASTM E96. Water absorption shall be less than 0.10 per ASTM C272.
- 1. Board shall be secured to ductwork with mechanical fasteners within 3" (max.) of board edges and 12" (max.) on center.
 - 2. All joints shall be closed with matching 3" pressure-sensitive tape or with a vapor barrier mastic reinforced with 3" glass scrim tape. For outdoor systems, the standard facing must be overcoated with a suitable weather barrier mastic reinforced with fabric or mesh.

3. Un-faced insulation systems may be finished using finishing cement reinforced with wire mesh and corner bead or sheet metal lagging properly overlapped and secured.
- C. Jackets for Ductwork Insulation: Self adhering aluminum jacket. Flexclad 400 by MFM or equal by Venture Tape or K Flex.
- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulating manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturer's recommendations.
- C. Verify by inspecting product labeling, submittal, data, and/or certifications which may accompany the shipments that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 PREPARATION

- A. All pipe, ductwork and equipment surfaces over which insulation is to be installed shall be clean and dry when insulation is applied.
- B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- C. Ensure that pressure testing of piping or duct systems has been completed prior to installing insulation. Ensure that all seams and joints in ductwork have been sealed by the contractor responsible for the ductwork.
- D. All adhesives, cements and mastics to be compatible with materials applied without attacking materials in either wet or dry state.

3.3 INSTALLATION OF PIPE INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions and NAIMA National Insulation Standards to ensure that insulation serves its intended purpose.
- B. Install insulation on systems subsequent to installation of heat tracing, painting, testing and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. In exposed areas, orient and cover seams in least visible locations.

- D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. For insulated pipes conveying fluids above ambient temperature:
1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Provide no less than 3 mitered sections per 90 degree elbow. Finish with fitting covers as specified.
 3. For hot piping conveying fluids 160 degrees F or less, do not insulate flanges and unions at equipment, and bevel and seal ends of insulation.
 4. For hot piping conveying fluids over 160, insulate flanges and unions at equipment.
- F. For insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjacent pipe. Provide no less than 3 mitered sections per 90 degree elbow. Finish with fitting covers as specified.
 3. Maintain integrity of vapor-barrier jackets on insulation, and protect to prevent puncture, tears, or other damage.
 4. All valve stems must be sealed with caulking that allows free movement of the stem but provides a seal against moisture incursion.
- G. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
1. Exception: Do not insulate valves in systems operating above 60 degrees F and where installed in valve boxes outdoors. Paint valves with a rust-resistant product equivalent to Rustoleum.
- H. Fittings and valves shall be insulated with fabricated sections of pipe insulation of same material as pipe insulation. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed aluminum fitting covers or as otherwise specified on contract drawings.
1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with a suitable weather or vapor resistant mastic as dictated by the system location and service.
 2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
 3. On cold systems (below ambient temperature), particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier.
- I. Extend insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- J. All final pipe insulation ends shall be tapered and sealed regardless of service.

- K. All piping shall be supported in such a manner that neither the insulation or the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing must be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier must be continuous, including material covered by the hanger saddle.
1. Piping systems 1-1/2" in diameter or less, insulated with low density insulation, may be supported by placing galvanized steel shields of the proper length and spacing located between pipe hangers or pipe hanger rolls and insulation.
 2. For hot or cold piping systems larger than 1-1/2" in diameter, operating at temperatures less than +200°F and insulated with low density insulation, shields as above and high density inserts such as cellular glass foam with sufficient compressive strength shall be used to support the weight of the piping system. At temperatures exceeding +200°F, Calcium Silicate pipe insulation shall be used for high density inserts.
 - a. Insert location: Between support shield and piping and under the finish jacket.
 - b. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - c. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.
 3. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.
 4. Thermal expansion and contraction of the piping and insulation system can generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used.
 5. On vertical runs, insulation support rings shall be used.
- L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with 0.020" aluminum jacket equivalent to Childers and cover fittings with factory formed aluminum covers equivalent to Elljacs.
- 3.4 INSTALLATION OF DUCT SYSTEM INSULATION
- A. General: Install insulation products in accordance with manufacturer's written instructions and NAIMA National Insulation Standards to ensure that insulation serves its intended purpose.
- B. Rigid Insulation:
1. Board shall be secured to ductwork with mechanical fasteners and insulation caps and washers within 3" (max.) of board edges and 12" (max.) on center.
 2. All joints shall be firmly butted and closed with matching 3" pressure-sensitive tape or with a vapor barrier mastic reinforced with 3" glass scrim tape. For outdoor systems, the standard facing must be overcoated with a suitable weather barrier mastic reinforced with fabric or mesh.
 3. Un-faced insulation systems may be finished using finishing cement reinforced with wire mesh and corner bead or sheet metal lagging properly overlapped and secured.

4. Corner angles shall be installed on all external corners of rigid insulation prior to installing the jacket.

C. Insulated ductwork or equipment operating below ambient temperature:

1. Provide insulation with vapor barrier jacket and seal all edges, seams, joints, punctures or any other breaks in vapor barrier with commercial grade, aluminum vapor barrier tape.
2. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations, except as noted otherwise for rated assemblies.

D. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and dampers with insulation of like material and thickness as adjoining duct, and finish with glass mesh reinforced vapor barrier cement. Cover with self adhesive aluminum jacket.

3.5 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.6 SAFETY PRECAUTIONS

- A. Insulation Contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.
- B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.7 FIELD QUALITY ASSURANCE

- A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.8 INSULATION REPAIR

- A. Repair damaged sections of mechanical insulation damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.9 PIPING SYSTEM INSULATION SCHEDULE

- A. Insulate the following piping systems with material and thickness as scheduled below:

PIPING SYSTEM TYPES	FLUID TEMP RANGE, °F	INSULATION SPEC. TYPE	PIPE SIZES ^a					
			Runouts up to 2" ^b	<1"	1" to 1¼"	1½ to 3"	4" to 6"	8" and up
Water Source Supply/Return	60 - 90	D	1	1	1	2	2	2

Refrigerant	40-110	E	1	1	1	1	1	1

3.10 DUCTWORK SYSTEM INSULATION SCHEDULE

A. Insulate the following ductwork application with material and thickness as scheduled below:

<u>Service</u>	<u>Material</u>	<u>Thickness</u>
All Ductwork on roof	Expanded Polystyrene Board	3"

See detail 2/M1.1 for requirements which will increase thickness of insulation supplied.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe and pipe fittings for:
 - 1. Water Source Heat Pump piping system.
 - 2. Equipment drains and overflows.

1.2 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B31.5 - Refrigeration Piping.
- D. ASME B31.9 - Building Services Piping.
- E. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc coated Welded and Seamless.
- F. ASTM A234 - Piping Fitting of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- G. ASTM B32 - Solder Metal.
- H. ASTM B88 - Seamless Copper Water Tube.

1.3 GENERAL REQUIREMENTS

- A. Where more than one piping system material is utilized, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Use full port Teflon seat bronze ball valves whenever jointing dissimilar metals in open or closed systems.
- C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded connections to valve bodies, equipment or other apparatus.
- D. Except where shown otherwise, use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use ball or butterfly valves for throttling, bypass, or manual flow control requirements for water systems if special valves or fittings are not indicated.
- F. Use lug type butterfly valves to isolate equipment.
- G. Use 3/4 inch ball valve with cap for drains at low points of piping, bases of vertical risers, and at equipment.

1.4 QUALIFICATIONS

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- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three year documented experience.
- B. Installer: Company specializing in performing the work of this section with minimum three years documented experience.
- C. Welders: Certify in accordance with ASTM 31.1 and ASME SEC 9. Submit copy of certificate prior to beginning work.

1.5 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 Code for Installation of Piping Systems.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, store, protect and handle products to site under provision of Section 01600.
- B. Accept valves on site in shipping containers. Protect machined surfaces.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

A. WATER SOURCE HEAT PUMP SUPPLY & RETURN PIPING

- B. Steel Pipe: ASTM A53, Schedule 40.
 - 1. Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding typed fittings
 - 2. Joints: welded.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. Cold drains
 - 1. Schedule 40 PVC DWV, ASTM D2446
 - a) Fittings: Socket solvent weld, ASTM D2656

2.3 UNIONS, FLANGES, AND COUPLING

- A. Flanges for Pipe Over 2 inches
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Gaskets: 1/16 inch thick performed neoprene.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.

- C. Make piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space, and not interfere with use of space.
- D. Group piping whenever practical at common elevations
- E. Sleeve pipe passing through masonry partitions, walls and floors.
- F. Slope piping and arrange to drain at low points.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 3. Where inserts are omitted, drill concrete slab from below and provide expansion anchor or use an appropriate powder driven stud where permitted.
- I. Pipe Hangers and Supports:
 - 1. Install in accordance with ASTM B31.9.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 30 inches of each horizontal elbow or tee.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Arrange hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed insulated parallel and at same elevation, provide trapeze hangers.
 - 8. Prime coat exposed steel hangers and supports and prepare for finish painting. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- K. Provide access where valves and fittings are not exposed.
- L. Slope piping and arrange system to drain at low points. Use eccentric reducers to maintain proper grade.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- N. Install valves with stems upright or horizontal, not inverted.

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- O. All piping material shall be manufactured in the USA.
- P. Pipe Joints: Unless otherwise specified, join pipes as follows:
 - 1. Steel pipe 2-1/2" to 4", welded joints.
 - 2. For welded joints, use only welding type fittings and welding neck flanges with the following exception:
 - a) "Weldolet" or "Threadolet" type of welding fittings for intersection welding of small branches to mains may be used where branch is two-pipe sizes smaller than the main.
- Q. Do not make direct welded connections to valves, expansion joints, strainers, apparatus, or any other units which are intended to be removable.
- R. Install eccentric reducers flat side up to prevent trapping of air.
- S. Branch connections are to be made from center line of mains in horizontal runs. No branch connections are to be made from bottom of piping.
- T. Utilize long radius elbows for all piping greater than 2".

3.3 PRELIMINARY CLEANING

3.4 Clean new piping internally by flushing prior to the application of pressure tests.

3.5 FILLING OF WATER SYSTEMS

- A. Fill each water system with fresh water and vent air. Place systems back in operation with no air added from the work of this contract.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Extent of refrigerant piping work is indicated on drawings and by requirements of this section.
- B. Insulation of refrigerant piping is specified in other Division-23 sections, and is included as work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of refrigerant piping products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
- C. ANSI Compliance: Fabricate and install refrigerant piping in accordance with ANSI B31.5 "Refrigeration Piping", and extend applicable lower pressure limits to pressures below 15 psig.
- D. BOCA Compliance: Fabricate and install refrigerant piping in accordance with the latest BOCA Mechanical Code.
- E. ASHRAE Compliance: Fabricate and install refrigerant piping in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigerant".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for refrigerant piping materials and products.
- B. Brazing Certification: Certify brazing procedures, brazers and operators in accordance with ASME standards (ANSI B31.5).
- C. Record Drawings: At project closeout, submit record drawings of installed refrigerant piping and piping products, in accordance with requirements of Division 1.
- D. Maintenance Data: Submit maintenance data and parts lists for refrigerant piping materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 Code for Refrigeration Piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

2.2 BASIC PIPES AND PIPE FITTINGS

- A. Tube Size 1" through 4": Copper tube; Type ACR, hard-drawn temper; wrought-copper, solder-joint fittings; brazed joints.
- B. Tube Size ¾" and Smaller: Copper tube; Type ACR, soft annealed temper fittings; cast copper-alloy fittings for flared copper tubes; flared joints.
- C. Brazed Joints: Braze joints using American Welding Society (AWS) classification BCuP-4 for brazing filler metal.

2.3 BASIC PIPING SPECIALTIES

- A. General: Provide specialties complying with Section 23 26 00 "Piping Specialties", in accordance with the following listing:

- 1. Pipe escutcheons.
- 2. Drip pans.
- 3. Sleeves.
- 4. Sleeve seals.

2.4 BASIC SUPPORTS AND ANCHORS

- A. General: Provide supports and anchors complying with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors", in accordance with the following listing:
 - 1. Adjustable steel clevises, adjustable roller hangers, and adjustable pipe roll stands for horizontal piping hangers and supports.
 - 2. Two-bolted riser clamps for vertical piping supports.
 - 3. Concrete inserts, C-clamps, and steel brackets for building attachments.
 - 4. Protection shields for insulated piping support in hangers.
 - 5. Copper flashings for piping penetrations.

2.5 REFRIGERANT SPECIALTIES

- A. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL-listed, 350 psi working pressure.
- B. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL-listed, 200_F (93°C) temperature rating, 500 psi working pressure.
- C. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL-listed, 500 psi working pressure.
- D. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter-drier core, 500 psi working pressure.
- E. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.
- F. Acceptable Manufacturers: Subject to compliance with requirements, provide solenoid valves of one of the following:
 - 1. Alco Control Div.; Emerson Electric Co.
 - 2. Henry Valve Co.
 - 3. Parker-Hannifin Corp.; Refrigeration & Air-Conditioning Div.
 - 4. Sporlan Valve Co.

2.6 BASIC VIBRATION CONTROL:

- A. General: Provide vibration control products in accordance with the following listing:
1. Riser isolators.
 2. Riser support isolators.
 3. Flexible pipe connectors.

PART 3 – EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which refrigerant piping system materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF REFRIGERANT PIPING

- A. General: Install refrigerant piping in accordance with equipment manufacturer's recommendations.
- B. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.
- C. Bleed dry nitrogen through refrigerant piping during brazing operations.
- D. Underground Refrigerant Piping
1. Copper refrigerant pipes run underground shall be insulated per Section 23 07 00, and installed concentrically within oversized PVC conduit.
 2. PVC conduit shall be drainable and also shall be vented from both ends. Run conduit as a sleeve into chiller mechanical room wall and up out of ground at the outdoor condensing unit. Install a storm cap at the open ends of the conduit at the condensing unit to keep water out and let air in. Run small drain line from open end in Mechanical Room to nearest floor drain.
 3. Insulated refrigerant piping shall be supported within the PVC piping in such a way as to prevent direct contact of the insulated piping with the PVC conduit to prevent wetting of insulation and to permit draining.

3.3 INSTALLATION OF PIPING SPECIALTIES, SUPPORTS, AND ANCHORS

- A. Install piping specialties in accordance with requirements of respective Specification Section.

3.4 INSTALLATION OF SPECIAL REFRIGERANT VALVES

- A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions. Remove accessible internal parts before brazing, replace after joints are completed.
- B. Solenoid Valves: Install in refrigerant piping as indicated with stem pointing upwards.
1. Wiring of solenoid valves is specified in applicable Division-26 sections, and is included as work of this section.
 2. Wiring of solenoid valves is specified in applicable Division-26 sections, not work of this section.

3.5 INSTALLATION OF REFRIGERANT ACCESSORIES

- A. Refrigerant Strainers: Install in refrigerant lines as required, and in accessible location for service.
- B. Moisture-Liquid Indicators: Install as required on refrigerant liquid lines, in accessible location.
- C. Refrigerant Filter-Dryers: Install in refrigerant lines as required, and in accessible location for service.
- D. Evaporator Pressure Regulators: Install in refrigerant suction lines or evaporator outlets as required. Adjust, if required, for proper evaporator pressure.
- E. Refrigerant Discharge Line Mufflers: Install as required, in horizontal or downflow portion of hot-gas lines, immediately after leaving compressor; not in riser.

3.6 EQUIPMENT CONNECTIONS

- A. General: Connect refrigerant piping to mechanical equipment and comply with equipment manufacturer's instructions.

3.7 FIELD QUALITY CONTROL

- A. Refrigerant Piping Leak Test: Prior to initial operation, clean and test refrigerant piping in accordance with ANSI B31.5, "Refrigeration Piping". Perform initial test with dry nitrogen, using soap solution to test all joints. Perform final test with 27" vacuum, and then 200 psi using halide torch. System must be entirely leak-free.
- B. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

3.8 DEHYDRATION AND CHARGING SYSTEM

- A. Install core in filter dryer after leak test but before evacuation.
- B. Evacuate refrigerant system with vacuum pump; until temperature of 35_F (2_C) is indicated on vacuum dehydration indicator.
- C. During evacuation, apply heat to pockets, elbows, and low spots in piping.
- D. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
- E. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
- F. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

3.9 ADJUSTING AND CLEANING

- A. Cleaning and Inspecting: Clean and inspect refrigerant piping system in accordance with requirements of applicable section.

END OF SECTION

SECTION 23 31 00

DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. The extent of the sheet metal work is indicated on the drawings and in the schedules, and by the requirements of this section. The types of ductwork and accessories specified in this section include but are not necessarily limited to the following:

1. Supply and return air systems.
2. Turning vanes.
3. Access doors.
4. Flexible duct connections.
5. Duct test holes.
6. Duct cleaning.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firm regularly engaged in the manufacture of duct accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1. Acceptable manufacturers include:
 - a. Semco
 - b. United McGill
 - c. United Sheet Metal
 - d. Durodyne
 - e. Hardcast
 - f. FanAir

B. When the system is in operation, the ductwork shall be free from rattles and air noises caused by poor duct construction.

1.3 REFERENCES:

A. Industry Standards: Comply with SMACNA (Sheet Metal and Air Conditioning Contractor's National Association) recommendations for fabrication, construction and details, and installation procedures, except as otherwise indicated.

B. SMACNA "HVAC Duct Construction Standards Metal and Flexible" and "Industrial Duct Construction Standards", Current Edition.

C. Comply with ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) recommendations, except as otherwise indicated.

D. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

1.4 PRODUCT HANDLING:

A. Protect shop fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCTWORK :

- A. General: Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated. Unless otherwise noted, pressure class shall be determined by fan rating.
- B. Materials:
1. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality; with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.
- C. Ductwork shall be constructed as indicated below:
1. Outdoor Ductwork: Outdoor duct shall be constructed to meet SMACNA Pressure Class 4" and Seal Class "A".
- D. Duct Sealant: Use non-hardening, water resistant, fire resistive, non-migrating mastic or liquid elastic sealant as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Tape is not acceptable for use as duct sealant. Sealant shall be less than 30 g/L VOC content. Ductwork shall be constructed and sealed to comply with the following seal classes per SMACNA standards: Seal Class A;
- E. Duct Fabrication: Duct sections shall be fabricated in maximum lengths of 8'-0" and shall conform to the sizes and routings shown, except that routing shall be changed and offsets provided by the contractor to avoid conflicts and/or obstructions encountered. Longitudinal seams in all ductwork shall be Pittsburgh locks. Ducts 12" wide and larger shall be cross broken. Duct fittings, connections, damper locations and construction, etc., shall be as indicated on the drawings. Details of construction not specifically shown or specified shall be as indicated on the SMACNA "Duct Manual and Sheet Metal Construction" Sections 1 and 2.
1. Change in the cross-sectional dimensions of ductwork is permissible when required to meet job conditions. Maintain at least the same equivalent cross-sectional duct area in accordance with the latest edition of the ASHRAE Guide. Secure the approval of the Professional prior to fabrication of ductwork requiring such changes.
 2. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Change duct sizes gradually, not exceeding 15 degrees wherever possible. Limit angular tapers to 45 degrees for contracting tapers and 30 degrees for expanding tapers.
 3. Where space permits, construct elbows with a minimum centerline radius to duct width ratio (r/W) of 1.5. Where space is limited, use curved elbows with splitter vanes spaced per SMACNA standards. Where r/W ratio can be between 0.75 and 1.0, 1 splitter vane may be used. Where r/W ratio must be between 0.70 and 0.60, 2 splitter vanes shall be used. If r/W ratio must be less than 0.60, then use 3 splitter vanes. Mitered elbows with turning vanes shall not be permitted unless conditions absolutely require it and prior approval is obtained from Engineer.
 4. If connection size equals or exceeds 25% of main size, use SMACNA Figure 2-7 "Parallel Flow Branches."
 5. For small branch connections other than above, use either low-loss rectangular 45 degree entry, conical or bellmouth fittings per SMACNA Figure 2-8, "Branch Connections." Straight spin-in fittings are not acceptable. Where above "accessible" ceiling construction, the connection fittings shall contain the branch balancing damper.
 6. All ductwork must present a smooth interior and joints must be airtight.
 7. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Prime coat welded joints with zinc-rich paint.

2.2 TURNING VANES:

- A. Provide turning vanes in the size and type indicated with the following additional construction features:
 - 1. Blades: 2" galvanized steel for up to and including 18" ducts, 4 1/2" galvanized steel for ducts over 18".
 - 2. Construction: Single wall blade.
 - 3. Types: Fixed blades for 90 degree elbows.

2.3 DUCT ACCESS DOORS:

- A. General: Provide access doors at all locations of duct systems requiring service access including but not necessarily limited to: smoke dampers, fire dampers, smoke detectors, humidifiers, control accessories, tops and bottoms of risers for cleaning. Access doors shall close with air pressure. All access doors are to be fully accessible without obstruction.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, use double-wall construction with insulation between.
- D. Access doors smaller than 12 inches square may be secured with sash locks.
- E. Provide two hinges and tow sash licks for sizes up to 18 inches square, three hinges and tow compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- F. Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES:

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA Duct Construction Standards (pressure classification per adjacent ductwork), and as indicated.
- B. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz. per sq. yd., minimum tensile strength 220 lb. x 220 lb., minimum service temperature range -40F to 200F, approximately 2 inches wide, crimped into metal edging strip.
- C. For outdoor use provide coated polyester fabric, minimum density 24 oz. per sq. yd., minimum tensile strength 220 lb. x 220 lb., minimum service temperature range -40F to 250F, approximately 2 inches wide, crimped into metal edging strip. Provide assembly specifically recommended by manufacturer for outdoor use.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION:

- A. General: Assemble and install ductwork in accordance with recognized industry practices which will be in accordance with the leakage rates allowable for specified seal class, with no objectionable noise, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor. The internal surfaces of all ductwork shall be smooth. No sheet metal parts, tabs, angles, etc. may project into ducts unless specified to do so. All seams and joints shall be external.
- B. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements. Where possible, ductwork shall be fabricated in such a manner that seams and/or joints will not be cut for the installation of grilles, registers, or ceiling outlets. If cutting of seams or joints is unavoidable, the cut portion shall be properly reinforced to original strength.
- C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- D. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
1. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal cam with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
 2. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- E. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.
1. All ductwork shall be properly suspended or supported from the building structure. The duct hanging system is composed of three elements; the upper attachment to the building structure, the hanger itself and the lower attachment to the duct. The attachments, hangers and supports for all ductwork shall be in accordance with Section IV of the SMACNA Manual. Ductwork shall be seismically restrained as required by Code.
 - a. Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 2. Do not suspend any device or allow work installed by any trade to be suspended from ductwork, unless supports such as trapeze hangers are specifically designed to handle additional static loads.
 3. Provide supplementary steel as required to support ductwork with a maximum deflection of 0.08 inch.

3.2 DUCT SUPPORTS:

- A. Horizontal rigid ductwork shall be supported at not more than 8 feet o.c. and at each change of direction. Hangers shall be 1/4 inch all thread rod and angle iron securely attached to ductwork and to the structure. Ductwork shall be "sway-braced" to prevent longitudinal movement. Vertical duct risers shall be supported at each floor by angles or channels secured to the duct at the floor arranged to prevent conflicts with fire damper access. All exposed angles and metal surfaces less than ten (10) feet above the floor shall be beveled, flattened or ground smooth to prevent injury to pedestrians.
- B. Provide hangers as required to prevent sagging of the duct.

3.3 DUCTWORK LEAKAGE TESTS:

- A. It is essential that all air ductwork be practically air tight. There will be no requirement for formal duct leakage tests with apparatus. However, before being insulated or concealed, all ducts, shall be checked for leakage. The Contractor shall schedule a field observation with the Engineer before insulation is applied in order for the Engineer to review and accept the work. Any deficiencies causing noticeable leakage (noise or detected air movement) shall be corrected.

3.4 ACCESSORIES INSTALLATION:

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Where access door is for a smoke detector, access door shall be upstream of device to facilitate testing.
- D. Provide duct test holes where indicated and required for testing and balancing purposes. Seal with neoprene plugs.
- E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

3.6 TEMPORARY CLOSURE:

- A. Temporary Closure: At all ends of ducts provide temporary closure of polyethylene film or other covering which will prevent entrance of dust, paint overspray and debris until time connections are to be completed. Maintain closures until dust producing activities have ceased and building has been cleaned. Contractor is responsible for means and methods to deliver a clean, like new air system. Should project conditions require measures beyond what is specifically called for to achieve this, contractor is responsible for identifying and providing same at no additional cost to the owner.

END OF SECTION