

SECTION 23 00 10 - MECHANICAL GENERAL PROVISIONS



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Furnish all labor and material necessary to provide and install the complete mechanical portion of this Contract as called for herein and on accompanying drawings. Parts of the mechanical division may be bid separately or in combination, at the Contractor's option; however, it shall be the responsibility of the Contractor to assure himself that all items covered in the mechanical Division have been included if he chooses to accept separate bids.
- B. It is the intent of this specification that all materials with temperatures below ambient conditions or conveying any fluid/gas at temperatures below 70 deg. F be insulated to completely eliminate the potential for condensation. Unless specified elsewhere in these specifications, for materials that do not require and requiring occasional access, use 2" thick closed cell rubberized insulation with re-sealable fabric joints (hook and loop type).
- C. Contractor shall refer to the Architectural and Structural drawings and install equipment, piping, etc. to meet building and space requirements. No equipment shall be bid on or submitted for approval if it will not fit in the space provided.
- D. It is the intention of these specifications that all mechanical systems shall be furnished complete with all necessary valves, controls, insulation, piping devices, equipment, etc. necessary to provide a satisfactory installation that is complete and in good working order.
- E. Contractor shall visit the site and acquaint himself thoroughly with all existing facilities and conditions which would affect his portion of the work. Failure to do so shall not relieve the Contractor from the responsibility of installing his work to meet the conditions.
- F. Contractor shall protect the entire system and all parts thereof from injury throughout the project and up to acceptance of the work. Failure to do so shall be sufficient cause for the Architect to reject any piece of equipment.
- G. Provide as work of this Division (unless clearly and specifically indicated as a requirement of the Division 26 contractor on the Division 26 drawings) the following:
 - 1. 120V power to all temperature control panels, unit controllers, field devices, etc. as required.

2. Wiring of any remote start/stop switches, occupancy sensors, manual or automatic motor speed control devices, motorized damper actuators controlling Division 23 equipment.

1.3 BIDDING REQUIREMENTS AND RESPONSIBILITIES

- A. Prime bidder is responsible for all work, of all trades and sub-contractors bidding this project. It is the prime bidder's responsibility, prior to submitting a bid to ensure that sub-contractors coordinate all aspects of the work between trades, sub-contractors, etc. to the fullest extent possible.
- B. Prime bidder shall ensure that all sub-contractors, suppliers, equipment vendors, etc., obtain all necessary and pertinent contract document information pertaining to their work prior to the submission of a bid.
- C. Bidders of all or any portions of this section or division are required to review all contract documents including but not limited to Architectural drawings, Structural drawings, Mechanical drawings, Plumbing drawings, Electrical drawings, and Fire Alarm drawing section to coordinate requirements and responsibilities with and through prime bidder.
- D. Bidders of all or any portions of this section or division, by furnishing a bid on a portion of the prime contract are indicating that they have received all contract documents and coordinated services provided under their portion of the work with the prime bidder; they are indicating that they have expressed any pertinent questions (which would result from a detailed, thorough review of the entire set of contract documents) to the prime bidder in accordance with Division 01 requirements, prior to bidding.
- E. All timely, pertinent, questions provided in writing prior to bids, in accordance with Division 01 requirements, will be clarified, defined, or otherwise explained in written addendum and/or addendums prior to bids, in accordance in Division 01 requirements.
- F. It is not the intention of these contract documents to leave any issue relating to coordination between trades or sub-contractors vaguely defined. The intention is to define all issues, coordination matters, equipment requirements, sizes, routing, etc. to the satisfaction of the prime bidder, prior to receipt of bids.
- G. Bidders of all or any portions of this section or division, by virtue of the submission of a bid to the prime bidder, are indicating that they have reviewed the entire set of contract documents with due diligence and regard for the Owner's desire for a comprehensive and complete bid proposal; that they have expressed all concerns or questions requiring clarification on matters of coordination between trades and/or sub-contractors; that they have expressed any such concerns or questions in writing in accordance with Division 01 requirements.
- H. Prime bidders, by submission of a comprehensive bid on the project are indicating that the subcontractors selected in their bid have complied with all Division 01 requirements, that they have indicated in writing, prior to bidding, all questions or concerns requiring clarification and/or explanation and have documented any and all specific exclusions involving work that would generally be considered to be work of their trade. The prime

bidder shall coordinate all work so that anything excluded by the bidder of all or any portions of this section or division, have been addressed prior to bids in one of the following manners:

1. The work has been confirmed, by the prime bidder, to be work of another trade or subcontractor (whose proposal is also being accepted).
 - a. Clarification of the matter has been made through the prime design professional via written addendum and is clearly and mutually understood by the prime bidder and the party raising the issue/question, or seeking clarification.
 - b. The work has been accepted as the responsibility of the Contractor directly.

1.4 POST-BID VALUE ENGINEERING (V/E):

- A. Value Engineering (V/E) defined: For purposes of Division 23 Specifications, in accordance with all Division 01 Requirements and all Terms and Conditions of proposed contract between Owner and Contractor, Value Engineering (V/E) shall be defined as a "post bid" process, whereby the apparent low bidder (having submitted a proposal in strict accordance with Project Contract Documents, that exceeds the Owner's available funds for construction [AFC] for this specified project offers proposed changes ("Value Engineering") to the work. This proposed value engineering may alter or adjust aforementioned contract document requirements in exchange for financial and/or other consideration (in response to a specific request by the Owner/Owner's Representative).
- B. Value Engineering may not be considered, prior to scheduled receipt and review of Bid Proposals by the Owner and an official written request from the Owner/Owner's Representative expressing the Owner's desire to consider value engineering items.
- C. While it may be in the project Owner's interest to consider the first cost money saving that may be generated via alternatives and options generated via participation in Value Engineering, Division 23 contractor shall realize that substantive offers of Value Engineering (V/E), if accepted by the Owner, constitute a design-build agreement (offer and acceptance) with the owner, and drastically change the design concept of the project, as developed by the Professional of Record identified on the Contract Documents.
- D. Should Contractor offer, and the owner accept value engineering options that alter aspects of the system design, equipment, performance and/or performance verification or monitoring of respective systems, Contractor shall provide duly licensed professional engineering consultants working on behalf of the Contractor (including sub-contractors and equipment vendors/manufacturers) to review, approve and take professional responsibility for performance and suitability of V/E hybrid systems, materials or operational changes related to respective V/E items. The Contractor's licensed professional engineering consultants and the Contractor assume any and all responsibility for the design and suitability in terms of performance, of hybrid systems installed, as Contractor's Professional of Record, absolving the original project Professional of Record (identified on the original Contract Documents, released for the original project Bid/Negotiation) from responsibility for the V/E hybrid systems portion of the work.
- E. Division 23 Contractor, via the offer and acceptance of value engineering items on the project agrees to provide professional engineering design services and take full and complete responsibility for the hybrid design. Further, the Contractor's (V/E Items) professional of record (either employees, or independent consultants to the Contractor) through the offer and acceptance of V/E items, agree to indemnify and hold harmless the project owner, the

owner=s original A/E team (Professional of Record on behalf of the owner for the original Contract Documents) their heirs and assigns in regard to the V/E changes and their impact on the Division 23 systems altered, affected or modified, in whole or in part. The Professional of Record shown on the original Contract Documents in regard to the systems altered, adjusted, revised, modified or otherwise affected by the value engineering items implemented, shall be absolved of design responsibility as a result of implementation of V/E items, and their original use of Engineering Seals used for original Contract Documents, shall not apply.

1.5 MATERIAL AND EQUIPMENT

- A. The term "provide" when used in the Contract Documents shall mean “furnish and install” and includes all items necessary for the proper execution and completion of the Work.
- B. Specific reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect expressed in writing is equal to that specified.
- C. Coordinate and properly relate all Work of this Division to building structure and work of all other trades.
- D. Visit premises and become thoroughly familiar with existing conditions; verify all dimensions in field. Advise Architect of any discrepancies prior to Bid Date in accordance with Division 00.
- E. Do not rough-in for any item or equipment furnished by others or noted "Not in Contract" (NIC), without first receiving rough-in information or determining rough-in requirements from physically examining the existing equipment, receiving specific cut sheet information from the Owner=s representative, other trades and/or Architect. Rough-in services for ANIC” equipment as required, as the work progresses.
- F. Provide storage and protection for all equipment and materials in accordance with requirements of Division 00 and Division 01. Replace any equipment and materials damaged by improper handling, storage, or protection, at no additional cost to Owner.
- G. Keep premises clean in accordance with requirements of Division 00 and Division 01.

1.6 SUBSTITUTIONS

- A. Substitutions are allowed under La. R.S. 38:2291 and La R.S. 38:2292. Any requests for prior approval (as provided for under La. R.S. 38:2295) including any re-submitted data, shall be received by the Architect/Engineer a minimum of seven (7) working days prior to bid date. The Contractor shall recognize that it may be necessary to submit certain requests for prior approval sooner than the final date listed in the Instructions to Bidders, depending upon the complexity and completeness of the submittal. If, in the opinion of the Architect/Engineer, there is neither sufficient time available nor adequate descriptive data attached to the submittal, the submittal will not be considered. Except as otherwise

- specified, materials and equipment shall be new and bear the approval label of the Underwriters Laboratories, Inc. for the type of installation required.
- B. Basis of design of systems is based on specific equipment for performance, size, shape, color, construction material, etc... If the use of other manufacturer's equipment, even though approved by Architect, involves additional cost due to space requirements, foundation requirements, increased mechanical or electrical services, the cost of such extra work shall be borne by the contractor. Even though a manufacturer's name appears in the Contract Documents as having acceptable equipment, his equipment shall be classified as being a substitute to the equipment originally designed for and named in the Contract Documents. Substitute equipment, materials, etc., will not be allowed to deviate from basis of design requirements.
 - C. All requests for prior approval shall identify where proposed material matches or exceeds the performance of the equipment specified. In addition, such submittal shall also clearly identify all deficiencies compared to specified product. Submittal of general cut sheets will be returned rejected.

1.7 DRAWINGS AND SPECIFICATIONS

- A. The specific intent of these Contract Documents is to provide the various systems, equipment, etc. to the Owner complete and in a thoroughly calibrated and functional condition.
- B. The Drawings shall not be construed as shop drawings. In the event of a possible interference with piping or equipment of another trade, items requiring set grade and elevations shall have precedence over other items. Should any major interference develop, immediately notify the Architect.
- C. In laying out Work, refer to Contract Documents at all times in order to avoid interference and undue delays in the progress of the Work.
- D. Furnish all plumbing fixtures (with required accessories) shown on either the plumbing drawings or the architectural drawings. Review Architectural casework elevations and identify fixtures indicated. Provide fixtures indicated. Rough-in for all fixtures as work progress. Verify plumbing fixtures required from review of Mechanical and Architectural drawings, prior to fixture shop drawing submittal.

1.8 CODES AND REGULATIONS

- A. Work shall be in full accord with the most stringent interpretation of the State Sanitary Code, local ordinances, building codes, and other applicable national, local, and state regulations.
- B. Equipment shall conform to requirements and recommendations of the National Bureau of Fire Underwriters and National Fire Protection Association (NFPA).
- C. Items provided under this Division shall comply with the American National Standards Institute (ANSI) "Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People," ANSI A 117.1

- D. In the possible event of conflict between codes or regulations and Contract Documents, notify the Architect immediately. Codes and Standards represent minimum requirements. These specifications may exceed requirements in various codes and standards.

1.9 FEES, PERMITS, AND TAXES

- A. Obtain and pay for permits required for the Work of this Division. Pay fees in connection therewith, including necessary inspection fees.
- B. Pay any and all taxes levied for Work of this Division, including municipal and/or state sales tax where applicable.

1.10 MANUFACTURER'S DIRECTIONS

- A. Install and operate equipment and material in strict accord with manufacturer's installation and operating instructions. The manufacturer's instructions shall become part of the Contract Documents and shall supplement Drawings and Specifications.

1.11 SUBMITTAL DATA

- A. Submit shop drawings, project data, and samples in accordance with requirements of Division 01.
- B. Shop drawings shall consist of published ratings or capacity data, detailed construction drawings for fabricated items, wiring and control diagrams, performance curves, installation instructions, manufacturer's installation drawings, and other pertinent data. Submit drawings showing revisions to equipment layouts due to use of alternate or substitute equipment.
- C. Where approved manufacturers and suppliers of equipment, materials, etc. are unable to fully comply with Contract Document requirements, specifically call such deviations to attention of Architect on submittals. Type deviations on a separate sheet; underlined statements or notations on standard brochures, equipment fly sheets, etc. will not be accepted.
- D. Approval of submittals shall not relieve Contractor from furnishing required quantities and verifying dimensions. In addition, approval shall not waive original intent of Contract Documents.
- E. Failure to obtain written approval of equipment shall be considered sufficient grounds for rejection of said equipment regardless of the stage of completion of the project.

1.12 PROJECT RECORD DOCUMENTS

- A. Keep Project Record Documents in accordance with requirements of Division 00 and/or Division 01.
- B. During construction period, keep accurate records of installations made under this Division, paying particular attention to major interior and exterior underground and concealed piping, ductwork, etc.

1.13 EXCAVATING AND BACKFILLING

- A. Provide excavating and backfilling necessary for Work of this Division. Comply with provisions of Division 31, Earth Work, if applicable.
- B. Trenches shall be inspected by Code Authorities and/or Owner's Representative before and after piping is laid. Give Owner's Representative 24-hour notice for each inspection. If any trenches are filled without Owner's Representative inspection and as subsequently found to be deficient, the trenches shall be uncovered.
- C. Inspected, and then re-filled, if requested by Owner's Representative.
- D. Provide minimum 18 inches of cover or in compliance with local published frost line data (if greater than 18 inches) to finish grades or paving at water piping.
- E. For piping, provide bell holes at trench bottom to assure uniform bearing. Accurately grade trench bottoms by instrument before laying any pipe.
- F. Protect and maintain trenches in dry condition until piping has been inspected and approved. Immediately after approval, backfill trenches in tamped layers.
- G. Compact fill to satisfaction of Architect and/or Owner's Representative.

1.14 CUTTING AND PATCHING

- A. Comply with requirements of Division 00 and Division 01 regarding cutting and patching. Locate and timely install sleeves as required to minimize cutting and patching.
- B. Cutting, fitting, repairing, patching, and finishing of Work shall be done by craftsmen skilled in their respective trades. Where cutting is required, cut in such a manner as not to weaken structure, partitions, or floors. Holes required to be cut must be cut or drilled without breaking out around the holes. Where patching is necessary in finished areas of the building, the Architect will determine the extent of such patching and refinishing.
- C. Repairing Roadways and Walks: Coordinate all roadway work with authorities having jurisdiction. Cut and/or bore under roadways for connection of utilities as required. Coordinate work through Contractor. Where this Contract cuts or breaks roadways, or walks to lay the piping, he shall repair or replace these sections to match existing, unless specifically identified as the responsibility of others.

1.15 PAINTING

- A. Painting shall be provided under Division 09, unless specified otherwise. Leave exposed piping, materials, and equipment clean and free of rust, grease, dirt, etc. before and after painting.
- B. Factory finished equipment, fixtures, and materials which are marred, chipped, scratched, or otherwise unacceptable shall be repaired or replaced under this Division to Architect satisfaction, at no additional cost to Owner.
- C. Coordinate all painting requirements with prime bidder prior to bids.

- D. Paint all exposed piping inside and outside of building. Label all piping after painting in accordance with Section 230553. Utilize industry standard paint colors for respective system unless directed otherwise by Architect. Review proposed color scheme with Division 23 Requirements prior to ordering materials.

1.16 GUARANTEE

- A. The Contractor shall guarantee all materials, equipment, and workmanship for a period of one (1) year from the date of final acceptance of the project. This guarantee shall include furnishing of all labor and material necessary to make any repairs, adjustments or replacement of any equipment, parts, etc. necessary to restore the project to first class condition. This guarantee shall exclude only the changing or cleaning of filters. Warranties exceeding one (1) year are hereinafter specified with individual pieces of equipment.
- B. If the Contractor's office is in excess of a fifty (50) mile radius of the project, he shall appoint a local qualified contractor to perform any emergency repairs or adjustments required during the guarantee period. The name of the contractor appointed to provide emergency services shall be submitted to the Architect for his approval.

PART 2 - PRODUCTS

2.1 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish manufacturers operating and maintenance instructions, parts lists and sources of supply for replacements in accordance with Division 01.
- B. Provide the following operations and maintenance data:
 - 1. Complete sets of final and correct shop drawings, maintenance and replacement parts manuals, and operating instructions, for equipment supplied.
 - 2. Bind each set within a common binder. Index and organize with a table of contents, to permit quick and convenient reference.
 - 3. Provide a minimum of five (5) days of instruction in operation and maintenance of equipment to Owner's Representative maintenance force. Design a 2-week period, convenient to Owner's Representative, during which qualified personnel, including manufacturers' technicians and authorized factory trainers shall be available for Architect/Owner's Representative instruction.

2.2 RECORD DRAWINGS

- A. Provide "Record Drawings" in accordance with the Division 01, General Requirements, indicating in a neat and accurate manner a complete record of all revisions of the original design of the work.
 - 1. Include all changes and provide for an accurate record, on reproductions of the Contract drawings or on appropriate shop drawings, all deviations between the work shown and work installed.
- B. Submit for approval bound sets of the required drawings, manuals and operating instructions.

2.3 IDENTIFICATION MARKINGS

- A. General: Apply identification tags, markers, etc. after insulation and field painting are completed.

PART 3 - EXECUTION

3.1 COORDINATION AND LAYOUT

- A. Study Drawings and Specifications to ensure completeness of work required.
 - 1. Include supplementary items normal to manufacturers' requirements or standard accepted trade practices as necessary to complete work, though not specifically indicated or specified.
- B. Verify measurements and conditions in field before starting work.
- C. Examine materials to which work is to be applied and notify the Architect/Owner=s Representative, in writing, of any conditions existing which are detrimental to proper and expeditious installation of work.
 - 1. Starting of work shall be construed as acceptance of conditions.
- D. Confer with other trades, install work to avoid interference with other trades, and possible necessary adjustments to conform to structural conditions and work of other trades.
- E. Coordinate and set inserts and locate openings in floors and walls in new construction.
 - 1. Locate pipes and ducts to avoid interference with other work shown on the drawings and as directed by the Architect/Owner=s Representative.
 - 2. Keep all concealed pipes and ducts within the enclosing construction provided.
 - 3. Arrange exposed work neatly in parallel runs and parallel with walls or structure, with uniformly spaced hangers and supports, and within the spaces assigned for each kind of work.
- F. Make coordinated layouts showing concrete work required for housekeeping pads, equipment bases and inertia masses which are cast in place, including the location of anchors and dowels.
 - 1. Coordinate the scheduling and placing of the concrete to suit the mechanical work schedules.
 - 2. Concrete housekeeping pads are to cover the full area of each piece of equipment. Concrete bases are to be of dimension and heights to suit the equipment. The forming and placing of concrete shall be provided under this specification section.

3.2 MAINTENANCE OF EQUIPMENT AND SYSTEM PRIOR TO FINAL ACCEPTANCE

- A. Maintain all installed equipment and systems in accordance with the manufacturer=s published instructions, until final acceptance by the Architect/Owner=s Representative, and

take such measures as necessary to ensure adequate protection of all equipment and materials during delivery, storage, installation, operating and shut-down conditions.

1. This responsibility shall include all provisions required to meet the conditions incidental to the delays pending final test of systems and equipment.
 2. Maintain and periodically clean all equipment until final acceptance.
- B. After installation of systems has been completed, operate the system to determine the capability of the equipment and controls to conform to the requirements of the drawings and specifications prior to performance testing.

3.3 DAMAGED EQUIPMENT

- A. Any and all equipment, parts, components, etc., provided under this division which is damaged by the Contract or which is received in damaged condition during shipping, transit, handling, or during installation shall be replaced. Dented, or damaged non-structural equipment jackets or surface casings such as but not limited to water heater jackets, boiler jackets, chiller insulation jackets, etc., shall either be repaired or replaced at the option of the Owner=s Representative. If repaired, the finished product shall match original equipment exactly.
- B. Any equipment which develops surface rust, either through improper storage, handling or installation, shall be refinished by grinding the affected area down to bare (white) metal, then prepared with a rust preventive primer and finished with the original manufacturer=s touch-up paint to match existing color.

3.4 EQUIPMENT INSTALLATION

- A. Locate and set equipment anchor bolts, dowels and aligning devices for all equipment requiring them. Coordinate requirements of concrete work with Contractor and other trades.
1. Level the equipment and grout solid between the equipment and the surface below. Grout to be premixed grout mixed in accordance with manufacturer's specifications.
- B. The field assembly, installation and alignment of equipment is to be done under field supervision provided by the manufacturer or with inspections, adjustments and approval by the manufacturer.
- C. Equipment startup.
1. Contractor shall provide qualified start-up personnel, certified by equipment manufacturer, to inspect and approve equipment and to supervise the operating tests of the equipment. System commissioning shall be performed in accordance with ASHRAE standards.
- D. Equipment and system test operation.
1. Note: Equipment and system test operation is separate and apart from additional requirements of training and demonstration. Refer to individual sections for requirements regarding training and demonstration. Notify the Owner=s Representative in advance of beginning the equipment and system test operation.

All equipment testing/demonstration shall be performed in the presence of the Architect/Owner=s Representative. A minimum of seven (7) days notice is required before equipment and system testing.

2. Each piece of equipment shall be operated in its system as long as required to provide proper functioning.
3. Perform an operating test of each complete system for twenty-four hours continuous operation as a minimum, or as long as required to provide coordination and proper functioning of all related systems and controls.
4. The operating criteria for each test shall be determined in advance with the Owner=s Representative approval whenever seasonal conditions shall not produce a full design load on any equipment or system.
5. Certify to the Owner=s Representative that all equipment is functioning properly.
6. Should the apparatus fail to meet the Contract requirements, adjust, repair or replace all defective or inoperative parts and again conduct the complete performance tests.

3.5 CLEANING AND ADJUSTING OF SYSTEMS

- A. Blow out, clean and flush each system of piping, ductwork and equipment to thoroughly clean the systems.
 1. Clean all materials and equipment, and leave in condition ready to operate and receive succeeding finishes where required.
 2. Adjust and align all equipment interconnected with couplings or belts.
 - a. Adjust valves of all types and operating equipment of all types to provide proper operation.
 - b. Remove and clean elements in all steam trap bodies.
 - c. Clean all strainers. Replace temporary construction screens with new permanent screens.
- B. Permanent equipment operated during construction shall not be abused or be used in service different from its design application.
 1. Temporary disposable filters shall be used during temporary operation.
 2. All expendable media, including belts used for temporary operation and similar expendable materials shall be replaced just prior to acceptance.
 3. Packing boxes of equipment operated during construction must be replaced just prior to system acceptance, using materials and methods specified by the supplying manufacturer.
- C. Equipment furnished with factory finishes where damaged shall be retouched and repainted to present a new appearance.
- D. Furnish and maintain protection for all of the work whether completed or in progress.
 1. Furnish and install coverings and enclosures as required.
- E. New and existing operating equipment and systems shall be clean and dust free inside and out.

1. Concealed and unoccupied areas such as plenums, pipe and duct spaces and Equipment Rooms shall be free of rubbish and swept, vacuumed, or wiped clean at time of acceptance.

3.6 CONTRACTOR REQUESTED FIELD OBSERVATIONS

- A. During the course of, and at stages appropriate to the progress of construction, the Contractor may request field observations of the design professional. If the field observation is a request of and by the Contractor, the Contractor shall provide all necessary ladders, scaffolding, lifts, safety harnesses or other equipment in order for the Architect to safely and adequately perform the requested observations.
 1. Requests for observations shall be made a minimum of seven (7) days in advance of the requested date of observation.
 2. All equipment, ladders, lifts, safety nets, scaffolding, etc., shall be provided and in place for the use of the Architect.
 3. All equipment panel covers, electrical panels, or other equipment shall be opened by the Contractor for viewing by the Architect.
 4. The Contractor shall make available a mechanic or technician of that field in order to answer questions of the designer, make any and all adjustments and/or corrections and to assist the Architect.

3.7 TESTING AND BALANCING

- A. Refer to Specifications Section 230593.

3.8 PAINTING

- A. General painting is typically performed by the Division 09 Contractor. This Contract shall however, either perform specialized painting as called for below in the following conditions or he shall advise the Contractor of these requirements as follows:
 1. Thoroughly clean all surfaces, requiring prime painting, of rust, loose scale, oil and grease.
 2. Dry surfaces before painting.
 3. Do not paint controls, nameplates, labels or sprinklers.
- B. Paint all equipment unless otherwise specified not to be painted at the factory with one prime coat of rust prohibitive paint.
- C. Provide field painting as follows:
 1. All exposed iron work, including un-insulated ferrous piping and conduit system components, hangers, supports, equipment bases, and apparatus; prime coat with a red lead-free paint.
 2. Un-insulated duct work and casing exposed to view and exposed galvanized surfaces of conduit and piping and of equipment prime painted at the shop: Prime coat, zinc chromate for galvanized surfaces.

3. Inside of all duct work where visible through registers and grilles: One coat of flat black paint.

3.9 CONNECTIONS TO EQUIPMENT

- A. Provide mechanical connections to equipment and fixtures requiring such connections which are supplied by Architect/Owner=s Representative or under other divisions.
- B. Provide unions, nipples, adapters, valves, flexible connections, and other trim required for final connections for each such fixture or item of equipment, as required for complete operation, servicing, and maintenance.

3.10 WORKMANSHIP

- A. Perform all work in a practical, neat and workmanlike manner with mechanics skilled in work, and using the best practices of the trade involved.
- B. No work shall be concealed until it has been inspected and approved by the Architect/Owner=s Representative.
- C. Workmanship or materials not meeting with requirements of the specifications and drawings and satisfaction of the Architect/Owner=s Representative shall be rejected and immediately replaced in an acceptable manner, without additional cost to the Architect/Owner=s Representative.

3.11 LUBRICATION

- A. All equipment furnished, installed, or connected under this division, shall be inspected for proper lubrication when connected and before operation of the equipment is begun, as recommended by the Manufacturer.
- B. The Contractor for the work of this division shall be held responsible for any damage to equipment that is operated without having been properly lubricated.

3.12 USE OF PREMISES AND CLEANING

- A. Remove and dispose of all waste materials and rubbish due to all construction operations under the Contract, except as otherwise noted, and keep the building free from rubbish and dirt caused by his and/or his Sub-Contractors' employees.
 1. During the entire progress of the work, rubbish removal shall be made frequently so as to prevent any potential safety or health hazard.
- B. Upon completion of the work, remove all protection, paint, putty, and other stains from all fixtures and glass and leave the premises thoroughly broom cleaned.

3.13 CUTTING, ALTERING AND PATCHING

- A. Provide all cutting, chasing, drilling, altering and rough patching required for the work of this division.

- B. Do all shoring, bracing, cutting, patching, piecing out, filling in, repairing and refinishing of all present work as made necessary by the alteration and the installation of new work.
- C. All holes and openings occurring in the existing floors after equipment, partitions, floors, steel work, conduits and pipes are removed or installed shall be closed up with materials similar to the adjacent work.
- D. The size and location of items requiring an opening, chase or other provisions to receive it shall be given by the trade requiring same in ample time to avoid undue cutting of any new work to be installed. These provisions shall not relieve the Contractor from keeping other trades informed as to the required opening, chases, etc., nor from responsibility for the correctness thereof, nor for cutting and repairing after the new work is in place.
- E. Include all cutting, repairing, and patching in connection with the work that may be required to make the several parts come together properly and fit it to receive or be received by the work of other trades, as shown on the drawings and/or specified, or reasonably implied by the drawings and specifications.
- F. All repairing, patching, piecing-out, filling-in, restoring and refinishing shall be neatly done by mechanics skilled in their trade to leave same in condition satisfactory to the Architect/Owner=s Representative.
- G. Materials and their methods of application for patching shall comply with applicable requirements of the specifications.
 - 1. Materials and workmanship not covered by the specifications and items of work exposed to view adjoining existing work to remain shall conform to similar materials and workmanship existing in or adjacent to the spaces to be altered.
- H. Cutting, repairing, and patching shall include all items shown on the drawings, specified in the specifications or required by the installation of new work or the removal of existing work.
- I. Remove partitions, walls, suspended ceilings, etc., as necessary to perform the required alterations or new construction work.
 - 1. Avoid damage to construction and finishes that are to remain.
- J. Protect and be responsible for the existing building, facilities and improvements if any.
 - 1. Any disturbance or damage to the work, the existing building, and improvements, or any impairments of facilities resulting from the construction operations, shall be promptly rectified, with the disturbed, damaged, or impaired work, restored, repaired or replaced at no extra cost.
- K. All alterations which are not indicated on the drawings nor specified herein but necessary to make good existing work disturbed by reason of the work shall be restored to a condition satisfactory to the Architect/Owner=s Representative.
- L. All holes in masonry floors and walls are to be core drilled.

- M. Disturbed concrete and /or cement floor areas shall be patched with approved type latex mortar.
 - 1. When cement mortar is used for patching, the surfaces shall be depressed a minimum depth of one inch (1").
- N. Reinstall all weather protection work in waterproof manner.
- O. Openings in roofs:
 - 1. Openings in roofs shall be kept properly plugged and caulked at all times, except when being worked on, to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed.
- P. Temporary openings.
 - 1. All temporary openings cut in walls, floors or ceilings for pipe or duct work shall be closed off with transite or an equally non-combustible material except when mechanics are actually working at the particular opening.

3.14 USE OF PERMANENT SYSTEMS:

- A. Heating System:
 - 1. The Contractor may, at his option, utilize the permanent heating systems provided under this Contract to provide space heating prior to Project completion date. The fuel for such space heating and for required tests of heating equipment shall be provided by Contractor.
 - 2. The heating system shall be operated only by qualified personnel, and shall be operated with all auxiliaries, and in accordance with manufacturer's instructions and good operating practice. If at any time the Owner's Representative determines that the equipment is being improperly operated or maintained, Contractor may be directed to disconnect its use.
 - 3. Heating systems shall be operated and controlled to prevent temperature in any room or space in any building from exceeding 90 deg. F.
 - 4. Systems may be activated without diffusers and registers in place, but filters with same efficiency as those specified shall be provided both in air handling equipment and at return air grille locations. Filter return air entering duct work, to prevent return air duct work from accumulating dust or otherwise becoming dirty.
 - 5. Contractor shall, prior to final acceptance of the Work, place heating systems and related equipment in a condition equal to new.
- B. Air Conditioning System:
 - 1. The Contractor may, at his option, utilize the permanent air conditioning systems provided under this Contract to provide space cooling prior to the Project completion date.
 - 2. The fuel, electricity or other energy required for space cooling and for any subsequent operation or testing shall be provided for by the Contractor.

3. The cooling system shall be operated only by fully qualified personnel and shall be operated with all auxiliaries, and in accordance with manufacturer=s instructions and good operating practice. Start up of equipment for use by the Contractor shall not commence any warranty period.
4. Cooling systems shall be operated and controlled to prevent temperature in any room or space in any building from falling below 70 deg. F.
5. Systems may be activated without diffusers and registers in place, but filters with same efficiency as those specified shall be provided both in air handling equipment and at return air grille locations. Filter all return air entering duct work, to prevent return air duct work from accumulating dust or otherwise becoming dirty.
6. Contractor shall, prior to final acceptance of the Work, place cooling systems and related equipment in a condition equal to new.

3.15 PENETRATIONS THROUGH FIRE SEPARATIONS

- A. Pack annular space between sleeve and pipe (insulation) and / or conduit in fire rated construction with fire retardant putty, sealant and / or caulk in accordance with listed assemblies utilized on the project. Material shall be non-asbestos based and installed in accordance with manufacturers instructions for fire rating required.
- B. Penetrations of multiple items and penetrations with annular space greater than 1/2" shall be provided with approved backing material in accordance with manufacturer's instructions.
- C. Fire retardant sealer and system shall meet ASTM E-84, ASTM E-814, and UL-1479.

END OF SECTION 23 00 10

SECTION 23 00 20 – BASIC MECHANICAL REQUIREMENTS



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 23. It expands and supplements the requirements specified in sections of Division 01.

1.3 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. Verify exact location and placement of all access panels with/through Architect prior to any equipment rough-in.
- B. Extend all grease fittings to an accessible location.
- C. Refer to the Division 08 Section: Access Doors.

1.4 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 23 for rough-in requirements.

1.5 MECHANICAL INSTALLATIONS

- A. Coordinate mechanical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, light fixtures, and other installations.
- J. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.6 MECHANICAL COORDINATION DRAWINGS

- A. Prepare and submit a set of coordination drawings showing major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing and maintaining insulation, servicing, and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- B. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Mechanical equipment room layouts;
 - 2. Specific equipment installations, including:
 - a. Ductwork and diffusers;
 - b. Pumps (new and existing) and piping connections
 - c. Air Handling equipment, fan coils and terminal units with accessories requirements.
 - 3. Work in pipe spaces, chases, trenches, and tunnels;
 - 4. Exterior wall penetrations;
 - 5. Ceiling plenums which contain piping, ductwork, or equipment in congested arrangement;
 - 6. Installations in mechanical riser shafts, at typical sections and crucial offsets and junctures;

7. Division 23 Contractor shall furnish drawings, to Contractor, once approved by reviewing Architect, to fully coordinate with all trades and subcontractors required. Failure to fully coordinate via this process shall not relieve the contractor of his responsibility to coordinate structural supports, electrical service routing of mechanical systems and provisions for required access.

1.7 CUTTING PATCHING AND SEALING OF PENETRATIONS

- A. This Article specifies the cutting and patching of mechanical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
- B. Refer to the Division 01 Section: CUTTING AND PATCHING for general requirements for cutting and patching.
- C. Refer to Division 26 Section for BASIC ELECTRICAL REQUIREMENTS for requirements for cutting and patching electrical equipment, components, and materials.
- D. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- E. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
- F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
- G. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 1. Uncover Work to provide for installation of ill-timed Work.
 2. Remove and replace defective Work.
 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 4. Remove samples of installed Work as specified for testing.
 5. Install equipment and materials in existing structures.
 6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
- H. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- K. Locate identify, and protect mechanical and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When

transit services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.

- L. Seal all penetrations of building envelope air and water tight. For complete closure of openings, where necessary, provide 1/8" thick elastomeric barrier anchored to materials penetrating building envelope and adjacent envelope surfaces involved - seal connections with caulk and mechanical fasteners. Refer to Architectural Sections on joints and sealants. Seal all conduit systems communicating between conditioned and unconditioned spaces. Coordinate all work with and through prime bidder and other trades. Unless otherwise directed, caulk sealant shall be long lasting polyurethane based products, resistant to UV exposure, installed in accordance with manufactures instructions. Sealant joints shall withstand building pressures variance with respect to ambient of 0.25 inches water gauge, with no leakage in terms of air and or water vapor.

1.8 MECHANICAL SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division 01 Section: Submittal Procedures for submittal definitions, requirements, and procedures.
- B. Submittal of bound shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect will not be processed.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders for requirements in selecting products and requesting substitutions.

2.2 PRODUCT LISTING

- A. Prepare listing of major mechanical equipment and materials for the project. A sample schedule is included at the end of this Section to complete this requirement.
- B. Provide all information requested.
- C. Submit this listing as a part of the submittal requirement specified in the Division 01.
- D. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
- E. Provide products which are compatible within systems and other connected items.

2.3 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Locate nameplates in an accessible location.

2.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

2.5 RECORD DOCUMENTS

- A. Refer to the Division 01 Section: Closeout Procedures for requirements. The following paragraphs supplement the requirements of Division 01.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Mark Specifications to indicate approved substitutions, Change Orders, actual equipment and materials used.

2.6 OPERATION AND MAINTENANCE DATA

- A. Refer to the Division 01 Section for Project Closeout or Operation and Maintenance Data for procedures and requirements for preparation and submittal of maintenance manuals.
- B. In addition to the information required by Division 01 for Maintenance Data, include the following information:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

- C. Submit in accordance with Section 017800.
- D. Use multiple binders if a single binder would exceed 2-1/2 inches in thickness; arrange the data in the same sequence as the specification sections; delete or mark through extraneous data.
- E. Provide tab pages with metal or plastic reinforced holes to separate each major item or closely related group of items with typed item names on the tabs. Supply a table of contents at the beginning of each volume listing at items, the manufacturers and the name, address and phone number of the nearest authorized service representative.
- F. A copy of the completed manual shall be submitted to the Contracting Officer one week before the user instruction for perusal. This copy will be returned to the Contractor with the user, comments. These comments shall be incorporated in the final copies of the manual. The Contractor shall obtain a signed receipt for the manual.
- G. The O & M Manual outline shall be prepared in two parts along the lines suggested in the 2019 HVAC Applications, Chapter 40.
- H. All contents shall be project specific, typewritten.

2.7 WARRANTIES

- A. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 23, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

2.8 CLEANING

- A. Refer to the Division 01 Section for general requirements for final cleaning.
- B. Refer to Division 230593 Section: TESTING, ADJUSTING, AND BALANCING for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

PART 3 - EXECUTION

3.1 WARRANTIES

- A. Refer to the Division 01 Section for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 23, into a separated set of vinyl covered, three ring binders, tabulated, and indexed for easy reference.

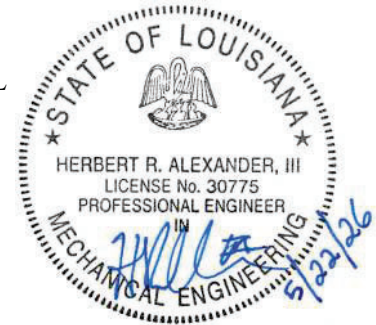
- C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

3.3 CLEANING

- A. Refer to the Division 01 Section for general requirements for final cleaning.
- B. Refer to Division 23 Section: TESTING, ADJUSTING, AND BALANCING for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

END OF SECTION 23 00 20

SECTION 23 05 10 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

A. Compliance with National Electric Code Requirements

1. Minimum Requirements:

- a. The requirements of this Division supercede the "Minimum" requirements of National Codes such as NEC in many areas. Where reference to this National Code is made, it is understood that the requirements of these codes are meant to indicate the "Minimum" requirements required by these Contract Documents and are not to infer that these "Minimum" requirements eliminate or in any way diminish the requirements of individual sections of these Contract Documents.
- b. Wherever compliance with this National Code is required, it shall be taken as a minimum requirement and applicable whenever the Contract Documents are silent with respect to specific requirements or installation procedures. The Contractor shall as a minimum, comply with the more stringent of the requirements.

B. Interlock Wiring for Mechanical Equipment

- 1. Interlocks & Wiring of Mechanical Equipment: It is the intent of the contract documents to note or include most of the obvious physical wiring, conduit, relays, and necessary interlocks between various pieces of mechanical/electrical equipment. Plans, details, specifications and drawings however, do not typically indicate the exact extent and encompassment of all required mechanical/electrical interlocks, routing, control voltages, conduit, wiring diagrams, etc., between mechanical and electrical devices and equipment that may be required for the proper operation and sequencing of equipment. Also, typically not indicated on the drawings is the differentiation between field installed and factory provided wiring because of the significant differences in requirements between various equipment manufacturer's requirements and/or job site conditions. It is the responsibility of this contractor to first verify that all mechanical related items affecting other trades are properly coordinated, accounted for and included in pricing prior to bid date. Additional costs for interlocks after bids are received will not be allowed for failure to coordinate.

Reference is made to coordination and responsibility of providing the required wiring diagrams and requirements between the various subs, etc. It remains however, the responsibility of this Contractor as further described in the following articles, to properly coordinate, be responsible for, and to allow for any and all costs associated with the requirements of the equipment manufacturer=s recommendations in order to preserve guarantees and warranties. (Note: For informational purposes only) - Typical mechanical/electrical/control/wiring interlocks covered under this section include but are not limited to the following examples:

- a. Domestic water pump interlocks with aquastats & thermostats.
- b. Exhaust fans and supply fan general ventilation interlocks.
- c. Smoke detector interlocks with supply air fans.
- d. Hi-Limit Temperature (firestat) interlocks with supply air fans.
- e. Lo-Limit Temperature (freezestat) interlocks with supply air fans.
- f. Interlocks between automatic safety float switches in emergency drain pans and respective fan motors and/or condensing units.
- g. Interlocks between Air Handling Unit AKill” switches and fan motor starters.
- h. Damper interlocks between required fire suppression systems.
- i. Fresh air damper interlocks with supply air fans.
- j. Two speed fan motors, number of conductors, and interlocks between motor starters and fan speed controllers.
- k. High limit temperature interlocks with unit heater thermostats.
- l. High and low water level limit interlocks with sump and ejector pumps.
- m. All other factory wired mechanical equipment requiring field installed connections and interfaces.

1.3 SUMMARY OF RESPONSIBILITY

- A. In order to ensure proper operation of mechanical equipment installed, it is the intent of this section of the specifications to ensure that the Division 23 Contractor is the ultimate party responsible for the proper electrical installation of the equipment provided under the technical specifications of this Division. Unless the Division 23 Contractor is fully licensed and qualified to provide a complete electrical installation, he shall obtain the services of a fully qualified electrical Contractor to perform those services required to provide a complete and operational system. If, however, the services of other Contractors or sub-contractors are required by the Division 23 Contractor in order that the equipment provided is to operate and perform as specified, the Division 23 Contractor shall obtain, pay for, and coordinate the services of such Contractor(s) in order to provide a complete a fully operational mechanical system. The Division 23 Contractor shall be fully responsible for the work of all sub-contractors and shall fully warrant their work in accordance with the requirements of Division 01 of these specifications.
- B. This section includes the basic requirements for field installed electrical conduits, power circuits, breakers, wiring, interlocks, and other electrical components which are to become an integral part of mechanical equipment provided under Division 23. All work performed under this section shall fully as a minimum, comply with Division 26 Specifications and National Electric Code - (latest edition) and shall be provided as listed below:
 1. All Afield-installed” interlock and/or control/power wiring necessary to provide a complete and operating mechanical system shall be ultimately provided by, and be

the responsibility of the Division 23 Contractor. These components shall include, but are not limited to the following examples:

- a. Automatic Temperature Control panels
- b. Installation and connection of factory installed motors
- c. Variable frequency drives
- d. Motors (single & multi-speed)
- e. Motor starters (single and multi-speed) for all Division 23 equipment
- f. Fire protection control panels
- g. Supply, return, & exhaust fan interlocks
- h. Plumbing fixture automatic flush valves
- i. Interlocks between domestic water circulating pumps & aquastats
- j. Exhaust fan/supply fan interlocks
- k. Filters at AHU=s
- l. AHU, hi-limit temperature interlocks, lo-limit temperature interlocks, smoke detectors, and other interlocks related to Life Safety protection.
- m. Other various interlocks between items of mechanical equipment, safeties, and field wired interconnections.

- C. It is the responsibility of the Division 23 Contractor to fully coordinate the electrical requirements of his mechanical equipment with the Division 26 Contractor prior to bidding and to ensure that other contractors and divisions are made aware of the requirements of his equipment that he intends to provide. The Division 23 Contractor shall provide wiring and control diagrams of all mechanical, air conditioning, ventilation, plumbing and /or fire protection equipment clearly delineating between factory wiring and field installed wiring. The mechanical contractor shall ensure that all field installed wiring, interlocks, etc., required to provide a complete and operable system are inclusive with his bid.
- D. Specific electrical power requirements (i.e., horsepower and electrical characteristics) where known, for mechanical equipment are scheduled on the Drawings or within the body of the individual technical specifications.
- E. Low Voltage Wiring: Low voltage wiring is not typically shown on the contract documents or plans. It remains however, the responsibility of the Division 23 Contractor to fully coordinate the low voltage electrical requirements of his mechanical equipment with the Division 26 Contractor prior to bidding and to ensure that other Contractors and Divisions are made aware of the requirements of his equipment that he intends to provide. The Division 23 Contractor shall also provide the low voltage wiring and control wiring diagrams of all mechanical, air conditioning, ventilation, plumbing and /or fire protection equipment clearly delineating between factory wiring and field installed wiring.
 1. The Division 23 Contractor shall coordinate with the Division 26 Contractor for all necessary power requirements.

1.4 REFERENCES

- A. NEMA Standards MG 1: Motors and Generators
- B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
- C. NEMA Standard 250: Enclosures for Electrical Equipment.

- D. NEMA Standard KS 1: Enclosed Switches.
 - E. As a minimum, comply with National Electrical Code (NFPA 70).
- 1.5 SUBMITTALS
- A. Motors, Starters, & VFD Drives: Provide manufacturer=s product data. If starters are an integral part of packaged mechanical equipment, then a separate starter submittal is not required.
 - B. Submit product data for motors, starters, variable frequency drives and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.
- 1.6 QUALITY ASSURANCE
- A. All electrical components and materials shall be UL labeled.

PART 2 - PRODUCTS

2.1 MOTORS

- A. The following are basic requirements for simple or common motors. For special duty motors, more detailed and specific requirements are specified in Section 230513 – AElectric Motors”.
- 1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
 - 2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
 - 3. Temperature Rating: Rated for 50 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
 - 4. Starting capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
 - 5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
 - 6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
 - a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
 - b. Bearings: Ball or roller or pillow block bearings with inner and outer shaft seals; re-greaseable, except permanently sealed where motor is normally inaccessible for regular maintenance; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
 - 7. Enclosure Type: Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation; totally enclosed, fan cooled for exterior applications or where specifically indicated on drawings.
 - 8. Overload protection: Built-in thermal overload protection.
 - 9. Noise rating: "Quiet"
 - 10. Efficiency: "Premium Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not

specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, test method B.

11. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.2 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor Starter Characteristics:

1. Enclosures: Unless otherwise specifically identified, provide NEMA 1, general purpose enclosures with padlock ears, except in wet or exterior locations, where enclosures shall be NEMA 3R with conduit hubs, or units in hazardous or dust laden atmospheres or other locations which shall have NEC rating for that particular proper class and division.
2. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

B. Magnetic Starters:

1. Refer to Section 230514 - AMotor Starters" for full requirements of motor starters.
2. As a minimum, provide the following items on each motor starter:
 - a. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
 - b. Trip-free thermal overload relays, each phase.
 - c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23- ABuilding Automation System" controls sections.
 - d. Built-in 120 volts control circuit transformer, fused from line side, where incoming electrical service exceeds 240 volts.
 - e. Lockable AOff" position handle.
 - f. H-O-A selector switch.
 - g. Externally operated manual reset.
 - h. Under-voltage release or protection.

C. Motor connections:

1. Flexible conduit, weatherproof type where installed in damp or wet locations as defined by the NEC, except where plug-in electrical cords are specifically indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify equipment physical size and clearances required.
- B. Verify electrical interlocks required.

3.2 THERMAL STOPS & BARRIERS

- A. Thermal Barriers: Where electrical equipment, conduit, wiring, etc., penetrates or comes into contact with cold or hot mechanical equipment, provide thermal barriers to prevent intrusion

of unconditioned air into mechanical equipment or to prevent electrical devices from sweating or accumulating condensation.

1. Examples: Examples of the above include but are not limited to:
 - a. Air handling conduit penetrations at or into AHU casings.
 - b. Smoke detectors attachment to hot or cold ductwork.

3.3 TRAINING & DEMONSTRATION

- A. Provide training as described in individual technical specifications.

END SECTION 23 05 10

SECTION 23 05 13 – ELECTRIC MOTORS



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes basic requirements for all motors connected to mechanical equipment. It includes motors that are factory-installed as part of equipment and appliances as well as field-installed motors.

1.3 QUALITY ASSURANCE

- A. As a minimum, comply with applicable local, state and federal codes.
- B. As a minimum, comply with applicable requirements of recognized industry associations which promulgate standards for the various trades. (See individual Sections of Division 23).
- C. Employ only qualified personnel for this work. Employ competent, qualified mechanics to supervise the work.
- D. As a minimum, comply with ASHRAE Standard 90.1 - 1999 (or latest edition) for motors.
- E. As a minimum, comply with NFPA 70, "National Electrical Code." (Latest Edition)
- F. NRTL Listing: Provide NRTL listed motors.
- G. Term "Listed": As defined in "National Electrical Code," Article 100.
- H. Listing Agency Qualifications: "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- I. As a minimum, comply with NEMA Standard MG 1, "Motors and Generators."
- J. As a minimum, comply with UL 1004, "Motors, Electric."

PART 2 - PRODUCTS

2.1 MOTORS, GENERAL

- A. General: Requirements below apply to motors covered by this Section except as otherwise indicated, for motors classified as simple or common motors (Section 230510).
 - 1. Motors 1.0 HP and Larger: Polyphase.
 - 2. Motors Smaller Than 1.0 HP: Single-phase.
 - 3. Frequency Rating: 60 Hz.
 - 4. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
 - a. 120 V Circuit: 115 V - motor rating.
 - b. 208 V Circuit: 200 V - motor rating.
 - c. 240 V Circuit: 230 V - motor rating.
 - d. 480 V Circuit: 460 V - motor rating.
 - 5. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
 - 6. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.
 - 7. Temperature Rise: Based on 40 deg. C ambient except 50 deg. C when otherwise indicated in equipment specifications or on equipment schedules on Plans.
 - 8. Enclosure: Open drip proof except where exposed to elements, weather, or where specifically called for on Drawings and/or equipment specifications.
- B. Manufacturers
 - 1. Acceptable Manufacturers: Subject to the following requirements, provide motors from one of the following manufacturers:
 - a. Baldor
 - b. Marathon
 - c. U.S. Motors
 - d. General Electric
 - e. Reliance

2.2 POLYPHASE MOTORS

- A. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated in equipment specifications.
 - 1. NEMA Design Letter Designation: "B" with 1.15 Service Factor.
 - 2. Multi-Speed Motors: Separate winding for each speed.
 - 3. Energy Efficient Motors: Premium Efficiency.
 - 4. Motors shall be complete with shaft grounding rings.
- B. Variable Speed Motors for Use with Solid-State Drives:
 - 1. NEMA Standard MG 1, Part 31, ADefinite Purpose Inverter Fed Motors", continuous duty, Design B, squirrel-cage induction units with ratings, characteristics, and features coordinated with and approved by the drive manufacturer. The motor shall include 1600-volt slot and phase paper insulation for protection against damage due to reflected waves.

2. Internal Thermal Overload Protection for Motors: Protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.
3. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading of the application.

2.3 SINGLE-PHASE MOTORS

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

2.4 MOTOR EFFICIENCIES

- A. Premium Efficiency Motors:
 1. All motors shall bear the NEMA APremium” label and shall meet or exceed the following nominal energy efficiency levels prescribed below for Design A or B continuous rated:

(The remainder of this page intentionally left blank)

Table 1 Nominal Efficiencies For ANEMA Premium™ Induction Motors
Rated 600 Volts or Less (Random Wound)

2.5 Open Drip Proof			Totally Enclosed Fan Cooled			
HP	6-Pole	4-Pole	2-Pole	6-Pole	4-Pole	2-Pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4
250	95.4	95.8	95.0	95.8	96.2	95.8
300	95.4	95.8	95.4	95.8	96.2	95.8
350	95.4	95.8	95.4	95.8	96.2	95.8
400	95.8	95.8	95.8	95.8	96.2	95.8
450	96.2	96.2	95.8	95.8	96.2	95.8
500	96.2	96.2	95.8	95.8	96.2	95.8

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: The following requirements apply to field-installed motors.
- B. Install motors in accordance with manufacturer's published instructions and the following:
 - 1. Direct Connected Motors: Mount securely in accurate alignment.
 - 2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

3.2 COMMISSIONING

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

3.3 TRAINING AND DEMONSTRATION

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
 - 1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 - 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 01, for Closeout Submittals and Division 23, Section 230020 - "Basic Mechanical Requirements."
 - 3. Provide Service Manuals for each motor specified.
- B. Provide three (3) hours of factory authorized training to Owner=s operating personnel.
 - 1. Schedule training with at least seven (7) days advanced notice to Owner=s Representative.
 - 2. Refer to Section 230010 - "Mechanical General Provisions" for video taping requirements.

END OF SECTION 23 05 13

SECTION 23 05 14 – MOTOR STARTERS



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. All motor starters specified under this section shall be provided by the same manufacturer.
- B. All motor starters installed in return air plenums shall be plenum rated.
- C. Extent of motor starter work is indicated by drawings and schedules. All motors and mechanical equipment provided with motors supplied by the Division 23 Contractor shall be also provided with Motor Starters and/or Variable Frequency Drives. It is the responsibility of the Division 23 Contractor to ensure that all Motor Starters/VFD=s are sized and suitable for the intended purpose of the mechanical equipment provided.
- D. Disconnecting means unless integral to the Starter/VFD shall be provided by the Division 26 Contractor.
- E. Types of motor starters specified in this section include the following:
 - 1. Magnetic.
 - 2. Manual.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacturer of motor starters, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing motor starters similar to that required for the project.
- C. NEC Compliance: As a minimum, comply with NEC as applicable to wiring methods, construction, and installation of motor starters.
- D. NFPA Compliance: As a minimum, comply with applicable requirements of NFPA 70E "Standard for Electrical Safety Requirements for Employee Workplaces".

- E. UL Compliance: As a minimum, comply with applicable requirements of UL 468A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", and UL 508, "Electrical Industrial Control Equipment", pertaining to installation of motor starters.
- F. IEE Compliance: As a minimum, comply with applicable requirements of IEE STD 241, "Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to motor starters.
- G. NEMA Compliance: As a minimum, comply with applicable portions of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies", Maximum), pertaining to motor controllers/starters and enclosures.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on motor starters.
- B. Shop Drawings: Submit layout drawings of motor starters showing accurately scaled equipment locations and spatial relationships to associated motors.
- C. Wiring Diagrams: Submit wiring diagrams for motor starters showing connections to electrical power panels, feeders, and equipment. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.
- D. Maintenance Stock - Fuses: For types and ratings required, furnish additional fuses, amounting to one set for every 10 installed units, but not less than 5 sets of each.

1.5 DELIVERY & STORAGE

- A. Motor Starter(s) shall be stored and handled per manufacturer=s recommendations.
 - 1. Deliver motor starter(s) from the factory properly secured, crated, and protected with factory plastic shrink wrap or other protective wrap.
 - 2. Lift and support motor starter(s) with the manufacturer's designated lifting or supporting points.
 - 3. Disassemble and reassemble motor starter(s) as required for movement into the final location following manufacturer's written instructions.
 - 4. Deliver motor starter(s) as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
 - 5. Store motor starter(s) to prevent damage to starter(s). Store units out of the elements and maintain factory protective covering until ready for installation.
- B. Lift and support motor starter(s) with the manufacturer's designated lifting or supporting points.
- C. Disassemble and reassemble motor starter(s) as required for movement into the final location following manufacturer's written instructions.
- D. Deliver motor starter(s) as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering motor starters which may be incorporated in the work are as follows:

1. Allen-Bradley Co.
2. Cutler Hammer Products, Eaton Corp.
3. General Electric Co.
4. GTE Products Corp.
5. Gould, Inc.
6. Square D Co.
7. Westinghouse Corp.
8. Siemens, Inc.

2.2 MOTOR STARTERS

- A. General: Except as otherwise indicated, provide motor starters and ancillary components which as a minimum, comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation.
- B. Magnetic Starter Requirements: Provide magnetic starters for motors 3/4 hp and larger, and for smaller motors where interlock or automatic operation with other equipment is indicated. Include the following accessories for all starters:
1. Provide UL Listing as a unit. Starters assembled with only UL components will not be acceptable.
 2. Maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
 3. Trip-free thermal adjustable overload relays, each phase.
 4. Interlocks, pneumatic switches, and similar devices as required for coordination with control requirements of Section 230900 – "Building Automation System" sections.
 5. Built-in 120-volt control circuit transformer with fused secondary, fused from line inside, where service exceeds 240 volts.
 6. Pilot Light; Red - AOn"
 7. Pilot Light; Green - AOff"
 8. Auxiliary Contact Block
 9. Externally operated manual AReset" overload relay button mounted on door/cover of the unit.
 10. 2-Point terminal strip with AH-O-A" Selector switch
 11. Hinged cabinet cover. Lift cover is not acceptable.
 12. Enclosure - Rated for exposure indicated on plans unless otherwise specifically indicated.
 13. Under-voltage release or protection.
 14. Lockable Handle AOff" position switch.

- C. AC Fractional HP Manual Starters: Provide manual single-phase fractional HP manual motor starters, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Starter to become inoperative when thermal unit is removed. Provide starters with double break silver alloy contacts, visible from both sides of starter; green pilot lights, and switch capable of being padlocked AOFF". Enclose starter unit in NEMA Type 1, 12, 4X, or 3R general purpose enclosure suitable for surface mounting according to the environment in which the starter is installed. Coat with manufacturer's standard color finish.
- D. Full Voltage Non-Reversing Starters: Starters for three phase motors 10 horsepower and below.
 - 1. Provide combination type starter/disconnect, full voltage non- reversing (FVNR), with magnetic NEMA rated contactors rated for horsepower of motor served.
 - 2. Adjustable trip magnetic circuit breaker disconnect (motor circuit protector) capable of being padlocked in the open position (power off).
 - 3. 10K AIC minimum fault rating with higher rating, when necessary, due to available fault levels.
 - 4. Starters shall have a fused 100VA minimum control transformer (120V, unless required otherwise).
 - 5. Provide HOA switch, push to test operating pilot light, solid state overload relays set for actual motor nameplate full load amps, and phase failure and phase reversal protection relays.
 - 6. Provide minimum two (2) N.O. and two (2) N.C. auxiliary contacts and terminal blocks factory pre-wired for field wiring.
 - 7. Starters shall be housed in a NEMA 1 enclosure for indoor applications and NEMA 3R enclosure for outdoor or wet locations. NEMA 12 enclosures shall be provided for installation in return air plenums or dirty/dusty indoor locations. NEMA 4X Stainless Steel enclosures shall be installed in corrosive environments.
 - 8. Coat with manufacturer's standard color finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS

- A. Install motor starters, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL, and NEMA standards, to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and electrical wiring/cabling work, as necessary to interface installation of motor starters with other work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.
- D. Install fuses in fusible disconnects, if any.

3.2 ADJUSTING AND CLEANING

- A. Inspect electrical starter's operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL

- A. Subsequent to connecting wire/cables, energize motor starter circuitry and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units, and then retest to demonstrate compliance. Ensure that direction of rotation of each motor fulfills requirements.

3.4 TRAINING & DEMONSTRATION

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
 - 1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 - 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 01, Section 017780 - "Closeout Submittals" and Division 23, Section 230020 - "Basic Mechanical Requirements."
 - 3. Provide Service Manual for each motor starter specified.
- B. Provide three (3) hours of factory authorized training.
 - 1. Refer to Section 230010 - "Mechanical General Provisions" for video taping requirements.
 - 2. Schedule training with Owner's Representative with at least seven (7) days notice.

END OF SECTION 23 05 14

SECTION 23 05 29 – HANGERS AND SUPPORTS



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

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

1.3 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product data for each type of hanger and support.
- C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

1.4 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code--Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. Listing and Labeling: Provide hangers and supports that are listed for their intended use.
 - 1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.
 - 1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
 - 2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

2.2 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in the Section specifying the equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.2 HANGER AND SUPPORT INSTALLATION

- A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and

attachments to properly support piping from building structure.

- B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
- C. Install supports with maximum spacings complying with MSS SP-69.
- D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
- E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
- F. Install concrete inserts in new construction prior to placing concrete.
- G. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- J. Support fire protection systems piping independent of other piping.
- K. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
 - 2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - 3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and have dimensions in inches not less than the

following:

THICKNESS NPS (Inches)	LENGTH (Inches)	
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105

4. Pipes 8 Inches and Larger: Include pressure treated wood inserts.
5. Insert Material: Length at least as long as the protective shield.
6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make a smooth bearing surface.
- C. Provide housekeeping pads where indicated on plans.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 ESCUTCHEONS, SLEEVES AND RISER CLAMPS

- A. Contractor shall furnish and install all escutcheons, inserts, thimbles, hangers, etc. required for the proper support and installation of his equipment and piping and he shall cooperate with other trades in locating and placing these items.

- B. Contractor shall furnish and install all piping sleeves required. Sleeves passing through structural members or concrete footings shall be of cast iron or Schedule 40 steel pipe. Sleeves passing through nonstructural walls or floors shall be of 26-gauge galvanized iron. Joints between sleeves and pipes passing through floors shall be made weather tight with plastic materials. Where pipes pass through water proofing membrane, flashing sleeves shall be installed. Sleeves of structural members shall be as detailed on structural plans.
- C. Provide malleable iron split ring hangers with rod supports as specified. Strap hangers or wire will not be accepted. Spacing of hangers shall be as required above by MSS Standards. Maximum spacing shall no case exceed the following: For cast iron pipes 5ft.; for other than soil pipes 10 ft.
- D. Provide galvanized iron shields between hangers and pipe covering.
- E. Provide heavy steel riser clamps on vertical risers at floors to support pipes.
- F. Provide chrome plated brass escutcheons wherever pipes pass through floors, walls or ceilings in exposed or finished areas.
- G. All piping projecting from chases shall be rigidly supported in the wall or chase. Loosely supported piping, fixtures or accessories will not be accepted.

3.7 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Division 09 Section "Paints and Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 48 – VIBRATION ISOLATION



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Work in this Section includes but is not limited to the following:
 - 1. Vibration isolation for piping, ductwork, and equipment.
 - 2. HVAC Equipment isolation bases.
 - 3. Flexible piping connections.
 - 4. Resilient pipe anchors and guides.
- B. Provide vibration isolation on all mechanical equipment, piping, and ductwork as indicated on equipment installation details or where recommended by equipment manufacturer.
 - 1. All equipment, piping and ductwork shall be mounted or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure.
 - 2. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- C. All isolation materials and equipment shall be provided by the same manufacturer.
- D. Any variance or non-compliance with this section shall be corrected by the contractor in a manner approved by the Owner=s Representative.
- E. Provide minimum static deflection of isolators for equipment in accordance with weight supported and associated seismic zone.

1.3 SECTION INCLUDES

- A. Mountings:
 - 1. Spring Mountings
 - 2. Restrained:
 - a. Spring

- B. Hangers:
 - 1. Spring & Neoprene
 - 2. Spring Only
- C. Bases:
 - 1. Integral Steel
 - 2. Saddle & Bracket
 - 3. Concrete Forms
 - a. Welded Base
 - b. Bolted Base
 - 4. Curb Mounted Aluminum Base
 - 5. Rooftop Spring Curbs
- D. Flexible Rubber Connectors
- E. Flexible Metallic Hoses
- F. Wall, Floor & Ceiling Seals
- G. Pipe Anchors
- H. Riser Guides
- I. Horizontal Pipe Isolation
- J. Pipe Riser Isolation
- K. Duct Isolation

1.4 SUBMITTALS

- A. Submit under provisions of Division 01, ASubmittal Procedures@.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.
 - 1. Submit details of equipment bases including dimensions, structural member sizes, and support point locations.
 - 2. Submit details of isolation hangers for ceiling hung equipment, piping, and ductwork.
 - 3. Submit details of mountings for floor supported equipment, piping and ductwork.
 - 4. All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements within the specifications.
 - 5. Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs in tabular form.
 - 6. Provide complete flexible connector details.
- C. Product Data:

1. Provide schedule of vibration isolator type with location and load on each.
 2. Provide schedules of flexibly mounted equipment, referenced by drawing number.
 3. Provide catalog cuts or data sheets on vibration isolators.
- D. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
- E. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01- ACloseout Procedures@ and ACloseout Submittals@.
- B. Record actual locations of isolation hangers including attachment points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Peabody
 2. Kinetics
 3. Mason Industries, Inc.
 4. Vibration Elimination Co., Inc.
- B. Substitutions: Under provisions of Division 01- ASubmittal Procedures@.

2.2 MOUNTINGS

- A. Type AB@ Isolation - Spring Isolators:
1. Design: Free standing, laterally stable without housing.
 2. Construction: All metal surfaces shall be neoprene coated
 - a. Provide molded neoprene cup or 1/4" neoprene acoustical friction pad between baseplate and support.
 - b. Provide leveling bolts rigidly attached to the equipment being isolated.
 - c. Installed and operating heights shall be the same.
 3. Ratio of spring diameter divided by the compression spring height shall be no less than 0.8.
 4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
 5. Submittals shall include spring diameters, deflection, compression spring height, and solid spring height.

6. Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
7. Mountings shall be Type ASLF@ as manufactured by Mason Industries, Inc. or approved equal.

B. Type "D" Isolation - Restrained Mountings:

1. Design: Steel springs similar to Type AB@ isolators described above but with neoprene acoustical pads within a rigid sided housing.
 - a. When equipment is at full operating weight, springs shall be adjustable to assume the weight placed and the temporary spacers removed.
 - b. Spacers shall be removable without changing the installed or operating weights.
 - c. Restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal modes.
 - d. The hole through the bushing shall be a minimum of 3/4" diameter larger than the restraining bolt.
 - e. Horizontal clearances on the side of the isolator between the spring assembly and the housing itself shall be a minimum of 2" to avoid bumping and interference with the spring action.
 - f. Provide vertical limit stop that are out of contact during normal operation.
2. Construction: Vertical stop limits to prevent spring extension when weight of equipment is removed
 - a. Temporary steel spacers shall be provided between the upper and lower housings.
 - b. Housing shall serve as blocking during erection.
 - c. Housing and springs shall be powder coated and hardware shall be electro-galvanized.
3. Mountings shall be Type ASLR@ as manufactured by Mason Industries, Inc. or approved equal.

2.3 HANGERS

A. Type AF@ Isolation - Spring & Neoprene Hangers:

1. Spring Isolators: Similar to Type AB@ previously described except with rigid steel frames containing 1 1/4" thick neoprene elements at the top with spring seated in a steel washer reinforced neoprene cup at the bottom.
 - a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
2. Spring hangers shall be Type A30N@ as manufactured by Mason Industries, Inc. or approved equal.

B. Type "H" Isolation - Hangers:

1. Hangers shall be manufactured with minimum characteristics as in Specification Type AB@, but without the neoprene element.

2. Springs shall be seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact.
3. Spring diameters and the lower hole sizes, shall be large enough to allow the hanger rod to swing through a 30-deg. arch from side to side before contacting the cup bushing.
4. If ducts are suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps.
5. Submittals on either of the above hangers shall include a scale drawing of the hanger showing the 30-deg. capability.
6. Hangers for rods shall be Type A30" or for straps, Type AW30N@ as manufactured by Mason Industries, Inc as basis of design.

2.4 HORIZONTAL TYPE THRUST RESTRAINTS

A. Type AI@ Isolation - Restraints:

1. When total air thrust exceeds 10% of the isolated weight, floor mounted or suspended air handling equipment shall be protected against excessive displacement by the use of horizontal thrust restraints.
2. The restraints shall consist of a modified Specification B spring mounting.
3. Restraint springs shall have the same deflection as the isolator springs.
4. The assembly shall be preset at the factory and fine-tuned in the field to allow for a maximum of 1/4" movement from stop to maximum thrust.
5. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure.
6. Restraints shall be attached at the center line of thrust and symmetrically on both side of the unit.
7. Horizontal thrust restraints shall be Type AWB@ as manufactured by Mason Industries, Inc. or approved equal.

2.5 BASES

A. Type AJ@ Steel Beam Bases:

1. Vibration isolation manufacturer shall furnish integral structural steel bases.
2. Rectangular bases are preferred for all equipment.
3. Pump bases may be T or L shaped.
4. Pump bases for split case pumps shall be large enough to support suction and discharge elbows.
5. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base.
6. Base depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
7. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1".
8. Bases shall be Type AWF@ as manufactured by Mason Industries, Inc. as basis of design.

B. Type AK@ Isolation - Bases:

1. Vibration isolation manufacturer shall provide steel members welded to height saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
2. Members shall have sufficient rigidity to prevent distortion of equipment.
3. Inverted saddles shall be Type AICS@ as manufactured by Mason Industries, Inc. as basis of design.

C. Type AL@ Isolation - Bases:

1. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating concrete bases.
 - a. Bases for split case pumps shall be large enough to provide support for suction and discharge elbows.
 - b. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6".
 - c. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity.
 - d. Forms shall include minimum concrete reinforcing consisting of 2" bars welded in place of 6" centers running both ways in a layer 1-1/2" above the bottom.
 - e. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor mounting locations to maintain a 1" clearance below the base.
 - f. Forms shall be factory painted with rust preventive prime coat suitable and ready for final finish coat.
 - g. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.
 - h. Base shall be Type ABMS@ or Type ABMK@ as manufactured by Mason Industries, Inc. or equal.

2.6 FLEXIBLE RUBBER CONNECTORS

A. Type AO@ Isolation -Connectors:

1. Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement.
 - a. Substitutions must have certifiable equal or superior characteristics.
2. Raised face rubber flanges shall encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable.
3. Size 1-1/2" through 14" shall have a ductile iron external ring between the two spheres.
 - a. Sizes 16" through 24" may be single sphere.
 - b. Sizes 3/4" through 2" may have one sphere, bolted threaded flange assemblies and cable retention.
4. Minimum ratings through 14" shall be 250 psi at 170 deg. F and 215 psi at 250 deg. F., 16" through 24", 180 psi at 170 deg. F and 150 psi at 250 deg. F.
 - a. Higher published rated connectors may be used where required.

5. Safety factors shall be a minimum of 3/1.
 - a. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.
6. The piping gap shall be equal to the length of the expansion joint under pressure.
 - a. Control rods passing through 2" thick Neoprene washer bushings large enough to take the thrust at 100psi of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them.
7. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
8. All expansion joints shall be installed on the equipment side of the shut off valves.
9. Expansion joints shall be ASAFEFLEX@, Type ASFDEJ@, Type @SFEJ@,TypeA SFDCCR@ or Type ASFU@ and Control Rods ACR@ as manufactured by Mason Industries, Inc. or approved equal.

2.7 FLEXIBLE METALLIC HOSES

A. Type AP@ Isolation - Hoses:

1. Flexible stainless-steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes may have male nipples. Minimum lengths shall be as tabulated below:

FLANGED CONNECTIONS		
3" x 14" (75 x 350mm)	6" x 20" (150 x 500mm)	12" x 28" (300 x 700mm)
4" x 15" (100 x 375mm)	8" x 22" (200 x 550mm)	14" x 30" (350 x 750mm)
5" x 19" (125 x 475mm)	10" x 26" (250 x 650mm)	16" x 32" (400 x 800mm)
MALE NIPPLES		
2" x 9" (12 x 225mm)	1-1/4" x 12" (32 x 300mm)	2" x 14" (50 x 350mm)
3/4" x 10" (19" x 250mm)	1-1/2" x 13" (38 x 325mm)	2-1/2" x 18" (64 x 450mm)
1" x 11" (25 x 275mm)	-----	-----

2. At equipment, hoses shall be installed on the equipment side of the shut-off valves horizontal and parallel to the equipment shafts wherever possible.
3. Hoses shall be Type ABSS@, Type ABSSRF@, or Type ABSSMN@ as manufactured by Mason Industries, Inc.

2.8 WALL, FLOOR AND CEILING SEALS

A. Type AQ@ Isolation - Seals:

1. Split seals consist of pipe halves with minimum 3/4" thick neoprene sponge cemented to the inner faces.
2. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping.
3. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member.
4. Seals shall project a minimum of 1" past either face of the wall.
5. Where temperature exceeds 240 deg. F., 10 lb. density fiberglass may be used in lieu of the sponge.
6. Seals shall be Type ASWS@ as manufactured by Mason Industries, Inc. or approved equal.

2.9 PIPE ANCHORS

A. Type AR@ Isolation - Anchors:

1. All directional acoustical pipe anchors, consist of two sizes of steel tubing separated by minimum 2" thickness of 60 durometer or softer neoprene.
2. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel.
3. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
4. All-directional anchors shall be Type AADA@ as manufactured by Mason Industries, Inc. or approved equal.

2.10 RISER GUIDES

A. Type AS@ Isolation - Guides:

1. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 2" thickness of 60 durometer or softer neoprene.
2. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction.
3. Guides shall be capable of $\pm 1-5/8$ " motion or to meet location requirements.
4. Pipe guides shall be type AVSG@ as manufactured by Mason Industries, Inc. or approved equal.

2.11 HORIZONTAL PIPE ISOLATION

A. Type AT@ Isolation - Isolators:

1. The first four (4) pipe hangers in the main lines near the mechanical equipment shall be as described in specification Type AG@.
2. Hangers supporting piping 2" and larger in all other locations throughout the building shall be isolated by hangers as described in Specification Type AF@.
3. Floor supported piping shall rest on isolators as described in Specification Type AD@.
4. Heat exchangers and expansion tanks are considered part of the piping run. The

- first four isolators from the isolated equipment shall have the same static deflection as specified for the mountings under the connected equipment.
5. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first four hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1-1/2" deflection for pipe sizes over 3" and up to and including 6", and 2-1/2" deflection thereafter.
 6. Where piping connects to mechanical equipment install specification Type AO@ expansion joints or Specification Type AP@ stainless hoses if Type AO@ is not suitable for the service.
 7. All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal, as described in Specification Type AQ@.

2.12 PIPE RISER ISOLATION

A. Type AU@ Isolation - Isolators:

1. All vertical risers shall be supported by spring isolators designed to support the riser filled with water.
2. Assigned loads must be within the building design load limits at the support points.
3. Neutral central resilient anchors close to the center of the run shall direct movement up and down.
4. Anchors shall be capable of holding an upward force equal to the water weight when the system is drained.
5. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors.
6. Resilient guides shall be spaced and sized properly depending on the pipe diameter.
7. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing.
8. The initial spring deflection shall be a minimum of 3/4" or four times the thermal movement at the isolator location whichever is greater.
9. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions.
10. Calculations must be stamped and signed by a licensed registered professional engineer.
11. Proper provisions shall be made for seismic protection in seismic zones. Support spring isolators shall be of Type AB@, Anchors of Type AR@ and telescoping guides of Type AS@ equipment.
12. The isolation vendor shall provide and design all brackets and clamps and anchors at riser spring guide and anchor locations.
13. The contractor shall install and adjust all isolators under the supervision and/or direction of the isolation vendor or his appointed representative.

2.13 DUCT ISOLATION

A. Type AV@ Isolation - Isolators:

1. All air ducts with a cross section of two (2) sq. ft. or greater shall be isolated from building structure by Type AH@ hangers or Type AB@ floor supports with a minimum deflection of 3/4".
2. Isolators shall continue for a minimum length of 50 ft. from the equipment being served.
3. If air velocity exceeds 1,000 fpm, hangers or supports shall continue for an additional 50 ft. from the unit or as further defined on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all isolators in strict accordance with manufacturer's instructions.
- B. Install isolation for motor driven equipment.
- C. Horizontal pipe shall be installed in accordance with Type AT@ Horizontal pipe isolators.
- D. Piping risers shall be installed in accordance with Type AU@ riser isolators.
- E. All duct runs shall be installed in accordance with Type AV@ duct isolators.
- F. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
 1. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
 2. The Contractor shall not install any equipment, piping, duct, or conduit which makes rigid connections with the building unless isolation is not specified. ABuilding@ includes, but is not limited to, slabs, beams, columns, studs and walls.
 3. Coordinate work with other trades to avoid rigid contact with building.
 4. Rooftop equipment isolators shall be bolted to the equipment and structure. Mountings must be designed to withstand and resist 110 mph wind loads. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight. Horizontal thrust restraints shall be Type AI@ restraints.
 5. Where piping passes through walls, floors, or ceilings, the vibration isolation manufacturer shall provide Type AQ@ seals.
 6. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the Contractor=s expense.
 7. Any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection shall be brought to the attention of the Owner=s Representative prior to installation.
 8. Locate isolation hangers as near to the overhead support structure as possible.
- G. Bases:
 1. Set steel bases for one-inch clearance between housekeeping pad and base.

2. Set concrete inertia bases for 2-inch clearance between housekeeping pad and base.
 3. Adjust equipment level.
 4. Provide painting for final finish coat.
- H. Install spring hangers without binding.
- I. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- J. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- K. Provide pairs of horizontal limit springs on fans with more than 6.0-inch 1.5 static pressure, and on hanger supported, horizontally mounted axial fans.
- L. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05-inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.
- M. Support piping connections to isolated equipment resiliently for scheduled distance as follows:
1. Up to 4 Inch Diameter: First three points of support.
 2. 5 to 8 Inch Diameter: First four points of support.
 3. 10-inch Diameter and Over: First six points of support.
 4. Select three hangers closest to vibration source for minimum 1.0-inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0-inch static deflection or 2 static deflection of isolated equipment.
- N. Connect wiring to isolated equipment with flexible hanging loop.

3.2 TRAINING AND DEMONSTRATION

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 01, "Closeout Submittals".
 3. Provide Service Manuals for each vibration isolator specified.
- B. Provide three (3) hours of factory authorized training.
1. Schedule training with seven (7) days advanced notice.
 2. Refer to AMechanical General Provisions@.

3.3 MANUFACTURER=S FILED SERVICES

- A. Examine systems under provisions of Division 01, ACloseout Procedures@.
- B. Inspect isolated equipment after installation and submit report. Include static deflections.

3.4 HORIZONTAL PIPE ISOLATION SCHEDULE

Pipe Size (Inches)	Isolated Distance from Equipment
1" & Below	120 Diameters
2	90 Diameters
3	80 Diameters
4	75 Diameters
5	70 Diameters
6	60 Diameters
8	60 Diameters
10	54 Diameters
12	50 Diameters
14	45 Diameters
16	45 Diameters
24	38 Diameters
Over 24	38 Diameters

3.5 EQUIPMENT ISOLATION SCHEDULE

ISOLATED EQUIPMENT	ISOLATOR Type/Base/Thickness	DEFLECTION * (inches)
Piping Risers	U (B-R-S)	0.75"
A/C Ductwork	V (H-B)	0.35"

Tubular & Axial Blowers	A-I	0.35"
Centrifugal Blowers	A-I	0.35"
Central Station Air Handling Units	A-I	0.35"

Note: All deflections are based upon slab on grade construction. For other applications, consult the isolation manufacturer and equipment schedules and adjust deflection accordingly.

Note: Seismic considerations shall be designed for the project in the area of earthquake zone location.

Equipment Types	Base Type	Isolator Type	Static Defl (in.)	Mason Ind. Type
Fans (including AHU, & FCU)				
Floor/Roof Supported	Per Mfr ⁽¹⁾	Spring		SLF
below - 300 rpm (or VFD)			4	
301 - 450 rpm			3.5	
451 - 600 rpm			3	
601 - 750 rpm			2	
751 - 850 rpm			1.5	
851 - greater			1	
Suspended		Sprg/Neop	(above + 0.25)	30N

(1) Vibration isolation scheme to consider fan operating force and provide thrust restraint and/or concrete inertia base in order to limit movement of fan to 1/4 inch at any operating point. Thrust restraints to have the same deflection as vibration isolation devices.

END OF SECTION 23 05 48

SECTION 23 05 53 – MECHANICAL IDENTIFICATION



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.
- E. Refrigerant Pipe Labels:
 - 1. The pipe identification shall be located at intervals not exceeding 20 feet (6096 mm) on the refrigerant piping or pipe insulation. The minimum height of lettering of the identification label shall be 1/2 inch (12.7 mm). The identification shall indicate equipment served designation, the refrigerant designation, and safety group classification of refrigerant used in the piping system. For Group A2, A3, B2 and B3 refrigerants, the identification shall also include the following statement: "DANGER—Risk of Fire or Explosion. Flammable Refrigerant." For any Group B refrigerant, the identification shall also include the following statement: "DANGER—Toxic Refrigerant."

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter

height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches.
 2. Fasteners: Brass grommet and wire .
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.
 1. Identification Paint: Use for contrasting background.
 2. Stencil Paint: Use for pipe marking.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of

- concealed piping.
- 5. Near major equipment items and other points of origination and termination.
- 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
- 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels (Excluding refrigerant piping).

3.4 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 CERTIFICATIONS

- A. The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications.
- B. TAB contractor shall be an independent third-party firm not associated with the Division 22 or 23 contractor.

1.3 SCOPE OF WORK

- A. The balancing, testing, and adjusting of the air conditioning, heating and ventilating systems shall be performed by an independent balancing company possessing calibrated instruments, qualified engineers and skilled technicians to perform all tests. The balancing agency shall be responsible for inspecting, adjusting, balancing, and logging the data on the performance of fans, air handling units, low pressure supply and exhaust ductwork, and heat exchangers. The Mechanical Contractor and the suppliers of the equipment installed shall cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to calibrate any deficiencies in construction.
- B. This Section specifies the requirements and procedures total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and recording and reporting the results.
- C. Test, adjust, and balance the following mechanical systems:
 - 1. Supply air systems, all pressure range;
 - 2. Fresh Air
 - 3. Exhaust Air
 - 4. Return air systems
 - 5. AHUs
 - 6. Fans
 - 7. Fire, smoke, and combination fire/smoke damper operation

8. Verify temperature control system operation;
- D. Provide assistance to Division 23 and Division 26 Contractor and project Architect in system commissioning process. Identify all system variances of greater than 10% and make required measurements, adjustments, etc. to bring systems into compliance to satisfaction of project Architect.
- E. THE TEST AND BALANCE CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING OUT AND REPORTING EACH SEQUENCE OF HEATING, COOLING AND CONTROL INTERLOCK OPERATION FOR THE EQUIPMENT REFERENCED ABOVE.

1.4 DEFINITIONS

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

1.5 SUBMITTALS

A. Agency Data:

1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.

B. Engineer and Technicians Data:

1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

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

D. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 01 and Section 230020.

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

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

1. Draft reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports.
3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
4. General Information and Summary
 - a. Air Systems
 - b. Hydronic Systems
 - c. Temperature Control Systems

- d. Special Systems
- 5. Report Contents: Provide the following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
 - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- 6. Provide electronic (PDF) copies of all documentation included in the Final Report.
- G. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.
- H. At the front of the Report, the TAB Contractor shall provide a summary sheet identifying system operational variances problems, etc. recommended corrective measures that in the opinion of the TAB Contractor should be enacted by the Mechanical Contractor prior to retesting. Submit to project Architect as work progresses with resolution documented for inclusion in final report.

1.6 QUALITY ASSURANCE

- A. Test and Balance Engineer's Qualifications: A Professional Engineer (independent consultant), registered in the State in which the services are to be performed, and having testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.
- B. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.7 PROJECT CONDITIONS

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

1.8 SEQUENCING AND SCHEDULING

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

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system, perform these steps:

1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
3. Compare design to installed equipment and field installations.
4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
5. Check filters for cleanliness.
6. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
8. Determine best locations in main and branch ductwork for most accurate duct traverses.
9. Place outlet dampers in the full open position.
10. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
11. Lubricate all motors and bearings.
12. Check fan belt tension.
13. Check fan rotation.

3.2 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

A. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean all strainers.
3. Examine hydronic systems and determine if water has been treated and cleaned.
4. Check pump rotation.
5. Clean and set automatic fill valves for required system pressure.
6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
7. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
8. Set temperature controls so all coils are calling for full flow.
9. Check operation of automatic bypass valves.
10. Check and set operating temperatures of chilled water heat exchangers to design requirements.
11. Lubricate all motors and bearings.
12. Test VAV boxes and hot water/electric heating coils.
13. Test sequencing of all motorized dampers, smoke dampers, etc.

3.3 MEASUREMENTS

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

3.4 PERFORMING TESTING, ADJUSTING, AND BALANCING

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

3.5 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
- C. Prepare a summary sheet of noted variances in excess of $\pm 10\%$ of design value. Include all such variances, recommended resolutions and ultimate result in Appendix AA” to TAB Final Report.

3.6 DEMONSTRATION

- A. Training:
 - 1. Train the Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with the Owner's personnel, the information contained in the Operating and Maintenance Data specified in Division 01 and 230020.
 - 2. Schedule training with Owner through the Architect with at least 7 days prior notice.

END OF SECTION 23 05 93

SECTION 23 07 13 - INSULATION



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. This Section includes:
 - 1. Piping insulation including fittings and valves.
 - 2. Duct insulation (internal lining and external wrapping)
 - 3. Mechanical equipment room walls and ceilings
 - 4. Mechanical equipment insulation.
- C. Cover and insulate all valves, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run and piping system. Install factory molded, pre-cut or field cut and fabricated units (at installer's option) except where specifically noted otherwise.
- D. Maintain the integrity of vapor jackets on all pipe insulation, duct insulation, equipment insulation and protect during construction to prevent puncture or other damage.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:
 - 1. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.
 - 2. Manufacturer's installation recommendations.
 - 3. Material certificates, signed by the manufacturer, certifying that materials as a minimum, comply with specified requirements where laboratory test reports cannot be obtained.
 - 4. Material test reports prepared by a qualified independent testing laboratory. Certify insulation meets specified requirements.

1.4 QUALITY ASSURANCE

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

1.5 SEQUENCING AND SCHEDULING

- A. Schedule piping and duct insulation application only after the testing of piping and duct systems is complete and accepted.
- B. Schedule insulation application after installation and testing of heat trace tape is complete and accepted.
- C. Schedule insulation of walls and ceiling to correspond with installation of pipe hangers, supports and equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pipe insulation shall not begin until all work has been tested and found to be tight. All insulation adhesives, sealers, tapes and mastic shall meet the latest NFPA requirements and shall meet 25/50/50 flame spread and smoke developed ratings.
- B. All insulation shall be installed in strict accordance with the manufacturer's recommendations.
- C. All pipe insulation where recommended by the manufacturer shall be banded with aluminum bands, three to a section and with one band on each side of each fitting, valve, etc.
- D. Insulation shall be continuous through walls and ceilings.
- E. All valves, strainers, etc. shall be insulated the same as its adjacent piping and the covering shall extend all the way up to the equipment.
 - 1. USE HIGH DENSITY INSULATION INSERTS AT HANGERS ON ALL PIPING 1-1/2" AND ABOVE TO PREVENT CRUSHING OF INSULATION.

2.2 THERMAL INSULATION

- A. After all work has been tested and approved, insulate as follows:
 - 1. INSULATION SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND INSTRUCTIONS.

2.3 CONDENSATE DRAIN PIPING

- A. Insulate with 1/2" Aerotube or Armaflex pipe insulation applied in accordance with manufacturer's recommendations and instructions.

2.4 STORM DRAINAGE PIPING WITHIN BUILDING, ROOF DRAIN BODIES (ABOVE SLAB)

- A. Shall be wrapped on outside with 2.33" thick, 3/4# density fiberglass insulation with aluminum foil vapor barrier. Insulation shall be taped at all joints and installed per manufacturer's recommendations.

2.5 REFRIGERANT LINES

- A. Insulate with 3/4" closed cell, tube insulation, Aerotube, Armaflex or equivalent. All insulation shall be sealed to not allow for any air to enter the insulation. Joints shall be glued and sealed per the insulation manufacturer's recommendation. All insulation located outdoors shall be jacketed with aluminum jacket or apply two coats of weatherproof mastic. Contractor shall install refrigerant lines below grade in watertight PVC sleeve in accordance with manufacturer's recommendations.
- B. All copper refrigerant lines shall be separated from dissimilar metals at all support points.

2.6 AIR HANDLING ROOM WALLS

- A. Furnish and install over entire areas of walls of air handling rooms containing a/c units a 1" thick Manville Linacoustic or equal acoustical type duct insulation 3# density, applied over Slick-Klips 12" on center. Stick-Klips shall be applied to wall with Miracle Adhesive. Acoustical material shall be applied over Stick-Klips with duct liner adhesive tape EC-104 spotted between pins. Stick-Klips with factor applied adhesive will not be acceptable.

2.7 HVAC DUCTWORK INSULATION:

- A. Supply, return, transfer, fresh air and exhaust ductwork shall be wrapped on outside with 3/4# density fiberglass insulation with aluminum foil vapor barrier with a minimum R-Value of R-6 (unless stated otherwise on mechanical drawings). Insulation shall be taped at all joints and installed per the manufacturer's recommendations.
- B. All ductwork exposed above open "slatted" ceiling above 115 Service Writers and 119 Waiting shall be completely wrapped on outside with 2.2", min. R-6 fiberglass insulation with black PSK vapor barrier (Johns Manville Microlite Black PSK or approved equal). Insulation shall be taped at all joints and installed per the manufacturer's recommendations.
- C. Refer to air distribution section of mechanical specifications for duct insulation supplied by the sheet metal sub-contractor.
- D. Transfer ductwork across walls shall be internally lined with 1" thick acoustical insulation.

2.8 HVAC FLEX-CONNECTIONS:

- A. Shall be wrapped on outside with 3/4 # density fiberglass insulation with aluminum foil vapor barrier with a minimum R-value of R-6. Insulation shall be taped at all joints and installed per the manufacturer's recommendations.

2.9 INSULATION THROUGH HANGERS AND SLEEVES

- A. The insulation shall be continuous through pipe hangers and pipe sleeves. At hangers where the pipe is supported by insulation, provide a galvanized iron protection shield. Provide pipes 2-inch i.p.s. and larger in insulation inserts at points of hanger supports. The inserts shall be of calcium silicate, cellular glass, prestressed molded glass fiber of minimum 13-pound density, or other approval material of the same thickness as adjacent insulation and not less than 13-pound density. The inserts shall have sufficient compression strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Inserts shall be 180 degrees and not less than the length of the protection shield. Vapor barrier facing of the insert shall be the same as the facing on the adjacent insulation. Where copper clad hangers are used on domestic copper pipe, insulation may cover pipe and hanger. Provide 18-gauge metal saddles between all hangers and insulation.

END OF SECTION 23 07 13



SECTION 23 09 00 - TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and install as hereinafter specified, a complete system of electronic temperature controls. This control system shall be as manufactured by Johnson Service Co. or approved equal. This system shall be installed and adjusted by mechanics regularly employed by the mechanical contractor. All equipment shall be of the manufacturer's first quality and shall be of full proportioning type.
- B. All temperature controls and instrumentation covered by this specification shall be manufactured, installed and supervised by the same manufacturer in order to consolidate the responsibility of this system to one manufacturer. The control system shall consist of all thermostats, central control panel and other necessary equipment to provide controls of the following:

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new and delivered to the jobsite in the manufacturer's original shipping package. Used or otherwise second class material shall not be acceptable.

2.2 THERMOSTATS

- A. Split System A/C unit thermostats shall be a 7-day programmable thermostat or approved equal. Thermostat shall be AUTOMATIC CHANGEOVER multistaged heating and cooling type and shall contain ON-OFF-AUTO switches for fan control and shall also contain HEAT-COOL switch for selection of mode of operation. Provide emergency auxiliary heat switch.

2.3 TEMPERATURE CONTROL WIRING INTERLOCK

- A. The control sub-contractor shall make complete and coordinated interlock wiring and supervisory central system wiring diagrams. This sub-contractor shall obtain necessary diagrams from the successful manufacturer and shall completely coordinated the interlock diagram.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Mechanical Contractor shall coordinate with the Electrical Contractor and shall provide all motor starters, etc., required for the completion of the electrical work.
- B. All control wiring 24V or 120V shall be provided by the Mechanical Contractor. Coordinate

with electrical contractor.

- C. All wiring required in the control systems, including electrical connections for the thermostats, firestats, smoke detectors, exhaust fans and all interlocking motor control wiring shall be furnished and installed by Mechanical Contractor.
- D. All wiring shall be in conduit and in accordance with the National Electrical Code (N.E.C.).
- E. All control wiring located outdoors shall be installed in rigid or intermediate metal conduit.
- F. All control wiring located indoors where an accessible ceiling is not available shall be installed in E.M.T. conduit.
- G. All control wiring located above accessible ceilings shall be N.E.C. approved cable. All control wiring located above accessible ceilings used as air plenums shall be N.E.C. approved "plenum cable".
- H. All conductors shall be copper. Conductors used for power circuits shall be #12 TW minimum. Conductors used for control circuits shall be #14 TW minimum. Conductors used for sensor circuits shall be #18 TW minimum.

3.2 FLOAT SWITCH:

- A. Provide float switch to emergency drain pan of each AHU. Switch shall be interlocked with AHU to de-energize the unit when the water level in the pan rises above a set level.

3.3 MOTORIZED DAMPERS:

- A. O.A. motorized dampers shall be interlocked with A/C units in respective mechanical rooms to open when any A/C compressor or heater cycles "on" and closed when cycled off units are "off". Provide all necessary relays, switches, transformers, etc. as required.
- B. Motorized dampers shall be furnished and set in place by contractor installing the ductwork.
- C. Damper actuators shall be 120/1/60 electric actuators specifically selected for damper manufacturer's requirements. Controls contractor shall furnish and install actuators. Coordinate all work with contractor installing dampers.

3.4 SEQUENCE OF CONTROLS

- A. Split Systems
 - 1. Supply fan start/stop: The supply fans will be started according to the schedule. After the supply fan has been started, the control sequence will be enabled. Outside air damper will open/close in conjunction with compressor or heater.
 - 2. Zone control: Modulate/cycle dx cooling to maintain the zone temperature at setpoint.
 - 3. Night setback/night setup: When in "unoccupied" mode, the unit will cycle as necessary to maintain the night setback zone temperature at setpoint. A differential prevents the unit from cycling excessively.
 - 4. SHUTDOWN:

- a. When the unit is shutdown by either a stop command or system safety the unit will be set as follows:
 - i. Supply fan will be off
 - ii. DX cooling or heating will be off
 - iii. Outside air damper will close.
 - iv. Fans
 - v. Reference fan schedule for controls.

END OF SECTION 23 09 00

SECTION 23 23 00 - REFRIGERANT PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Pressure relief valves.
- H. Filter-driers.
- I. Solenoid valves.
- J. Expansion valves.
- K. Receivers.
- L. Flexible connections.

1.2 REFERENCES

- A. ARI 495 - Refrigerant Liquid Receivers.
- B. ARI 710 - Liquid Line Dryers.
- C. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers
- D. ARI 750 - Thermostatic Refrigerant Expansion Valves.
- E. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.
- F. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- G. ASHRAE 34 - Number Designation of Refrigerants.
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.



- I. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.
- J. ASME B31.5 - Refrigeration Piping.
- K. ASME B31.9 - Building Services Piping.
- L. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- M. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- N. AWS A5.8 - Brazing Filler Metal.
- O. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- P. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- Q. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified 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. Provide pipe hangers and supports in accordance with ASTM B31.5 unless indicated otherwise.
- C. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.
- D. Valves
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gage taps at compressor inlet and outlet.
 - 3. Use gage taps at hot gas bypass regulators, inlet and outlet.
 - 4. Use check valves on compressor discharge.
 - 5. Use check valves on condenser liquid lines on multiple condenser systems.
- E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- F. Strainers:
 - 1. Use line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.

3. Use shut-off valve on each side of strainer.
 4. Pressure Relief Valves: Use on ASME receivers [and pipe to outdoors].
- G. Permanent Filter-Driers:
 1. Use in low temperature systems.
 2. Use in systems utilizing hermetic compressors.
 3. Use filter-driers for each solenoid valve.
- H. Solenoid Valves:
 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
 2. Use in liquid line of single or multiple evaporator systems.
 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- I. Receivers:
 1. Use on systems 5 tons and larger, sized to accommodate pump down charge.
 2. Use on systems with long piping runs.
 3. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS

- A. Submit under provisions of Section 23.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 23.
- B. Record exact locations of equipment and refrigeration accessories on record drawings.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 23.
- B. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.7 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this section.

1.8 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9.

- C. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01.
- B. Deliver and store piping and specialties in shipping containers with labeling in place.
- C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

1.10 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Section 01.
- B. Provide containers each with refrigerant.

PART 2 - PRODUCTS

2.1 PIPING

- A. Copper Tubing: ASTM B280, Type “K”, ACR hard drawn to be used between VRF outdoor condensing units and branch controllers.
- B. Copper Tubing: ASTM B280, pre-insulated Type “L”, ACR soft copper with brazed joints to be used between VRF branch controllers and VRF cassettes or air handlers.
- C. Fittings: ASME B16.22 wrought copper.
- D. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C). Brazing shall only occur once piping system has been purged and flowing dry nitrogen to prevent internal oxidation.
- E. Pipe Supports and Anchors:
 - 1. Conform to ASME B31.5.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 Inches (75 mm): Cast iron hook.
 - 6. Vertical Support: Steel riser clamp.
 - 7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 9. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

10. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.2 REFRIGERANT

- A. Refrigerant: ASHRAE 34;

1. R-410A

2.3 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure of 500 psig and maximum temperature of 200 degrees F.

2.4 VALVES

- A. Ball Valves:

1. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal lockable cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 300 degrees F.

- B. Service Valves:

1. Forged brass body with copper stubs, brass lockable caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig (3450 kPa).

2.5 STRAINERS

- A. Straight Line or Angle Line Type:

1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psig (2960 kPa).

2.6 CHECK VALVES

- A. Globe Type:

1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 500 psig and maximum temperature of 300 degrees F (149 degrees C).

2.7 PRESSURE REGULATORS

- A. Brass body, stainless steel diaphragm, direct acting adjustable over 0 to 80 psig (0 to 550 kPa) range, for maximum working pressure of 450 psig.

2.8 PRESSURE RELIEF VALVES

- A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 450 psig setting; selected to ASHRAE 15.

2.9 FILTER-DRIERS

- A. Permanent Straight Through Type:
 - 1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig.
 - 2. Rating: ARI 710 moisture rating.

2.10 SOLENOID VALVES

- A. Valve: ARI 760, pilot operated, copper or brass [or steel] body and internal parts, synthetic seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem shall permit manual operation in case of coil failure.

2.11 EXPANSION VALVES

- A. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, non-adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.12 RECEIVERS

- A. Internal Diameter 6 inch (150 mm) and Smaller:
 - 1. ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- B. Internal Diameter Over 6 inch (150 mm):
 - 1. ARI 495, welded steel, tested and stamped in accordance with ASME SEC 8D; 400 psig with tappings for liquid inlet and outlet valves, pressure relief valve.

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. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing 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 and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut [above] [flush with top of] [recessed into and grouted flush with slab.
- G. Pipe Hangers and Supports:
 - 1. Install in accordance with ASTM B31.5.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Provide copper plated hangers and supports for copper piping.
 - 8. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
 - 9. Provide clearance for installation of insulation and access to valves and fittings.
 - 10. Provide access to concealed valves and fittings.

11. Flood piping system with nitrogen when brazing.
12. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
13. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09900.
14. Insulate piping; refer to Section 15001 and Section 15200.
15. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
16. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
17. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
18. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01400.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psig (1470 kPa).

3.4 SCHEDULES

Pipe Hanger Spacing

PIPE SIZE Inches (mm)	MAX. HANGER SPACING Feet (m)	DIAMETER Inches (mm)
1/2 to 1-1/4 (12 to 32)	6.5 (2)	3/8 (9)
1-1/2 to 2 (38 to 50)	10 (3)	3/8 (9)
2-1/2 to 3 (62 to 75)	10 (3)	1/2 (13)
4 to 6 (100 to 150)	10 (3)	5/8 (15)
8 to 12 (100 to 150)	10 (3)	5/8 (22)

END OF SECTION 23 23 00



SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

A. Section Includes:

- 1. Single-wall rectangular ducts and fittings.
- 2. Single-wall round ducts and fittings.
- 3. Double-wall round and flat-oval ducts and fittings.
- 4. Sheet metal materials.
- 5. Sealants and gaskets.
- 6. Hangers and supports.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" "SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical System
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
- B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including but are not limited to the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
 - g. F/A devices, wi-fi antennas, etc.

E. Welding certificates.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow, LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Eastern Sheet Metal, Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. All round ductwork shall comply with latest SMACNA standards. All round ductwork 4 in. – 14 in. shall be a minimum 26 ga. steel.

2.3 DOUBLE-WALL ROUND INSULATED DUCT & FITTINGS

- A. Unless otherwise specified, all interior and outer shell duct and fittings shall be a minimum G-90 galvanized sheet metal in accordance with ASTM A525 and A527 specifications.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:
 - a. Eastern Sheet Metal, Inc.
 - b. Hamlin Sheetmetal, Inc.
 - c. United McGill, Inc.
 - d. Semco, Inc.
 2. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given

- sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not greater than 12 feet.
3. Round Ducts: Fabricate round supply ducts with "spiral lock seam" construction, except where interior diameters exceed 72 inches. As a minimum, comply with SMACNA "HVAC Duct Construction Standards," Second Edition - 1995 with addendums, Table 3-2A and 3-2B for galvanized steel gages.
- a. Round & Oval Ducts - Low Pressure: Solid welded (continuous welded), 1-inch insulation, perforated inner liner and with metal thickness listed below for pressure classes from minus 2 inches to plus 1 inch:
- i. 3 to 26 inches: 24 gage.
 - ii. 27 to 36 inches: 22 gage.
 - iii. 37 to 50 inches: 20 gage.
 - iv. 52 to 60 inches: 18 gage.
- b. Round & Oval Ducts - Medium Pressure: Solid welded (continuous welded), 1-inch insulation, perforated inner liner and with metal thickness listed below for pressure classes from 2 inches to plus 6 inches:
- i. 3 to 14 inches: 24 gage.
 - ii. 15 to 26 inches: 26 gage.
 - iii. 28 to 36 inches: 20 gage.
 - iv. 38 to 50 inches: 18 gage.
 - v. 52 to 78 inches: 14 gage.
4. Double-Wall (Insulated) Fittings: Fabricate double-wall insulated fittings with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.
- a. Thermal Conductivity: 0.27 Btu/sq.ft./deg. F/inch thickness at 75 deg. F mean temperature.
- b. Outer Shell: Base outer shell gage on actual outer shell dimensions. Gages for outer shell shall be same as for uninsulated fittings specified above.
- c. Insulation: Unless otherwise indicated, provide 1-inch-thick fiber-glass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.
- d. Perforated Inner Liner: Construct round and flat oval inner liners with perforated sheet metal of the gages listed below. Provide 3/32-inch-diameter perforations, with an overall open area of 23 percent. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."
- i. 3 to 34 inches: 24 gage.
 - ii. 35 to 58 inches: 22 gage.
 - iii. 60 to 88 inches: 20 gage.
- e. Connectors: Maintain concentricity of liner to outer shell by mechanical means. A second "inner" factory installed flange shall be provided to keep the inner liner concentric and to eliminate the need to make inner connections at the inner wall. Retain insulation from dislocation by mechanical means. Ductwork shall be provided with flanged connections (paint grip galvanized) at each fitting or coupling on all double wall ducts.

5. Exhibit Hall/General Assembly Exposed Ductwork: Drum louver taps are to be factory fabricated and installed double wall taps with factory installed air foil type extractors up to the first duct reducer. Extractors are to be field adjustable and provided with means of securing the extractor to the duct without the use of additional fasteners or attachments. The drum louver taps are to be of length suitable for the dimensions of the installed louver. Factory manifold taps shall be welded to the spiral duct. Tack or spot welds are not acceptable.

2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G60.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized. (Paint Grip)
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Rolled Mastic Sealant
 1. Pressure-Sensitive rolled mastic sealant comprised of a foil facer with butyl adhesive
 2. Rolled Mastic Sealant: 2-inch minimum width.
 3. Rolled Mastic Sealant: 17-mil thickness; minimum
 4. Water Resistant
 5. Mold and Mildew Resistant
 6. Maximum Pressure Class: 16-inch W.C., positive/negative
 7. Service: Indoor and Outdoor
 8. Service Temperature: Minus 20 F to 200 F
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum
 10. VOC: 0 g/l, EPA Standard Method 24
 11. UL 181B-FX
- C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 16-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
10. UL-181 Listed
11. UL 2818, Green Guard Compliance

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 16-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
13. UL-181 Listed

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 4. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 5. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 8. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 9. Conditioned Space, Return-Air Ducts: Seal Class C.
- C. Seal all duct penetrations through interior and exterior building walls For a complete penetration seal to the satisfaction of engineer.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for seismic restraints.

- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections

- installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
- 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- 3.8 DUCT CLEANING
- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
- 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
- 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within new duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 6. Provide drainage and cleanup for wash-down procedures.
 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

3.10 DUCT SCHEDULE

- A. Supply Ducts:
1. Ducts Connected Downstream of Fan Coil Units, and Terminal Units:

- a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12
 2. Ducts Connected to Variable-Air-Volume Air-Handling Units and Inlets of Terminal Units:
 - a. Pressure Class: Positive 4-inch wg
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- B. Return Ducts:
 1. Ducts Connected to Air-Handling Units
 - a. Pressure Class: Positive or negative 4-inch wg.
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 6
 - d. SMACNA Leakage Class for Round and Flat Oval: 6
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg>.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- C. Exhaust Ducts:
 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6
- E. Intermediate Reinforcement:
 1. Galvanized-Steel Ducts: Galvanized steel
- F. Elbow Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 700 fpm or Lower:
 - i. Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - ii. Mitered Type RE 4 without vanes.
 - b. Velocity 700 to 1500 fpm:
 - i. Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - ii. Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - iii. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - i. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - ii. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - iii. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - i. Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - ii. Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

- iii. Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
- iv. Radius-to Diameter Ratio: 1.5.
- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

J. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
- 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 – DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Manual volume control dampers.
 - 3. Motorized Dampers.
 - 4. Spin Collars.
 - 5. Fire Dampers.
 - 6. Smoke Dampers.
 - 7. Turning vanes.
 - 8. Duct-mounted access doors and panels.
 - 9. Flexible connectors.
 - 10. Flexible ducts.
 - 11. Accessories hardware.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
- B. Product data including details for materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Backdraft dampers.
 - 2. Manual volume control dampers.
 - 3. Motorized Dampers.
 - 4. Spin Collars.
 - 5. Fire Dampers.
 - 6. Smoke Dampers.
 - 7. Turning vanes.
 - 8. Duct-mounted access doors and panels.
 - 9. Flexible connectors.
 - 10. Flexible ducts.
 - 11. Accessories hardware.



- C. Shop drawings from manufacturer detailing assemblies. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail the following:
 - 1. Special fittings, volume control damper installation (both manual and automatic), and transformers details.
 - 2. Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installations.
- D. Product Certification: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static pressure loss, and dimensions and weights.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA Standards:
 - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 BACKDRAFT DAMPERS

- A. Description: Suitable for horizontal or vertical installation.
- B. Frame: 0.063-inch-thick 6063T extruded aluminum.
- C. Blades: 0.025-inch-thick roll-formed aluminum.
- D. Blades: 0.050-inch-thick 6063T extruded aluminum.
- E. Blade Seals: Vinyl.
- F. Blade Axles: Nonferrous.
- G. Tie Bars and Brackets: Aluminum.
- H. Return Spring: Adjustable tension.
- I. Wing-Nut Operator: Galvanized steel, with 1/4-inch galvanized-steel rod.
- J. Adjustable Pressure Controls.
- K. Dampers to be Greenheck EM-30, Ruskin BD6, Pottorff BD-150, or approved equal.

2.2 MANUAL VOLUME CONTROL DAMPERS

- A. General: Provide factory-fabricated volume-control dampers, complete with required hardware and accessories. Stiffen damper blades to provide stability under operating conditions. Provide locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Provide end bearings or other seals for ducts with pressure classifications of 3 inches or higher. Extend axles full length of damper blades. Provide bearings at both ends of operating shaft.
- B. Standard Volume Control Dampers: Multiple or single-blade, parallel or opposed-blade design as indicated, standard-leakage rating, with linkage outside of air stream, and suitable for horizontal or vertical applications. Greenheck MDB-15, Ruskin MD-15, Pottorff CD-10 & MD-41, or approved equal.
- C. Provide damper stand off bracket to accommodate duct insulation.

2.3 MOTORIZED DAMPERS

- A. Mechanical Contractor shall furnish and install motorized dampers as indicated on mechanical and architectural drawings. Damper shall be opposed blade motorized type equivalent to Greenheck Model VCD-23, Ruskin CD36/OB, Pottorff CD-41, or equal with actuators. Motorized dampers shall be operated by 120/1/60 electric actuator (low sound) as indicated on plans. Damper shall be complete with outboard support bearing, blade, and jamb seals. Dampers shall be low - leakage type. Dampers shall go to closed position when units are off unless otherwise noted.

2.4 SPIN COLLARS

- A. All round take-offs to round branch duct shall be made with 26-gauge spin-type collars with 26-gauge balancing dampers. These spin-collars shall be as manufactured by Flexmaster Model FLD, Dace MSD, or approved equivalent.
- B. The mounting groove shall be die-formed to assure constant fit control. Balancing dampers shall be factory-installed with spring loaded, retractable bearings and a positive locking wing-nut for easy adjustment.
- C. Provide damper stand off bracket to accommodate duct insulation.

2.5 FIRE DAMPERS

- A. General: UL labeled according to UL Standard 555 "Standard for Fire Dampers."
- B. Fire Rating: 1-1/2 or 3 hours, as indicated on Contract Drawings.
- C. Frame: Type B; fabricated with roll-formed, 22-gage, galvanized-steel; with mitered and interlocking corners.
- D. Style: Dynamic
- E. Mounting Sleeve: Factory-installed galvanized steel.
 - 1. Minimum Thickness: 16 ga thick as indicated, and length to suit application.

- 2. Factory installed sleeve shall be constructed of gauges as dictated by the manufacturers UL Listing.
 - 3. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of the wall or floor, and thickness of damper frame meets sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 22-gage galvanized steel (or as required by UL Listing). In place of interlocking blades, provide full-length, 21-gage, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include a blade lock and stainless steel negator closure spring.
- I. Fusible Link: Replaceable, 212 deg F rated.
- J. Dampers shall be 100% free area.
- K. Dampers shall be Ruskin DIB Series, Greenheck DFD Series, or equal.

2.6 SMOKE DAMPERS

- A. General: UL-labeled according to UL Standard 555S, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems." Combination fire and smoke dampers shall also be UL-labeled for 1-1/2-hour rating according to UL Standard 555 "Standard for Fire Dampers." Refer to Section 230900 "Building Automation System" for additional requirements.
- B. Damper shall bear a Class 1 Leakage rating.
- C. Fusible Link: Replaceable, 212 deg F rated.
- D. Frame and Blades: 16-gage galvanized steel (or as required by UL listing).
- E. Mounting Sleeve: Factory-installed, 18-gage galvanized steel (or as required by UL listing), length to suit wall or floor application.
- F. Actuators are to be 120 volt and provided by the damper manufacturer and be UL tested with the damper.
- G. Step-Down Transformers: Refer to electrical plans for transformer required to transform to 120V, single phase which comply with UL, FM NFPA Requirements for smoke control systems.
- H. Smoke Dampers shall include factory supplied and mounted damper test switch.
- I. Dampers shall be Ruskin SD37 or Greenheck SMD-20, Pottorff SD-141, or approved equal.

2.7 TURNING VANES

- A. Fabricate turning vanes according to SMACNA HVAC Duct Construction Standards, Figures 4-3.

- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, curved blades set at 3/4 inch) on center, support with bars perpendicular to blades set at 2 inches on center, and set into side strips suitable for mounting in ducts.

2.8 DUCT-MOUNTED ACCESS DOORS AND PANELS

- A. General: Provide construction and airtightness suitable for duct pressure class.
- B. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of hinges and locks as indicated for duct pressure class. Provide vision panel where indicated. Provide 1-inch by 1-inch butt hinge or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.
- E. Insulation: 1-inch- thick fiber glass or polystyrene foam board.
- F. Access doors shall be Ruskin Model ADH-22, Kees ADH, Pottorff HAD, or approved equal.
- G. Access doors for oval and round ducts shall be constructed of 20 ga steel with neoprene gasket and hand knobs for access. Access doors shall be Ruskin Model ADR/ADF, Greenheck RAD, or approved equal.

2.9 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.
- B. Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.

2.10 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts – Insulated (2.33", R-6): Factory-fabricated, insulated, round duct, with an outer aluminum jacket, glass fiber insulation around a continuous inner liner.
 - 1. Reinforcement: Steel-wire helix encapsulated in the inner liner.
 - 2. Outer Jacket: Glass-reinforced, silver mylar with a continuous hanging tab, integral fiber glass tape, and nylon hanging cord.
 - 3. Outer Jacket: Polyethylene film.
 - 4. Inner Liner: Polyethylene film for low pressure, woven glass fiber for high pressure.
 - 5. Medium pressure duct rated at 6" static pressure.
 - 6. Manufacturer: Thermaflex or approved equivalent.

2.11 ACCESSORIES HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pilot tube and other testing instruments and provide in length to suit duct insulation thickness.
- B. Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch, zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.
- E. Provide all necessary transformers, electrical components suitable for each system installation including duct damper controllers, fire dampers and smoke dampers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards.
- B. Install volume control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.
- C. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- D. Install fire and smoke dampers according to the manufacturer's UL-approved printed instructions.
- E. Install fusible links in fire dampers.
- F. Label access doors for fire dampers indicating damper type (Fire Damper, Fire Smoke Damper, Smoke Damper).

3.3 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.

- C. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00



SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 -

PART 2 - GENERAL

2.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2.2 SUMMARY

- A. Section Includes:

1. Ceiling-mounted fans.
2. In-line cabinet fans.
3. Centrifugal inline fans.
4. Centrifugal roof downblast fans.
5. Centrifugal roof upblast fans.
6. Centrifugal roof kitchen hood ventilator.
7. Centrifugal sidewall fans.
8. Sidewall propeller fans.
9. Upblast propeller roof exhaust fans.
10. Axial roof fans.

2.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

- B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

2.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 3 - PRODUCTS

3.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Loren Cook.
 - 2. GREENHECK.
 - 3. ACME
 - 4. Loren Cook Company.
 - 5. PennBarry.
 - 6. Twin City.

3.2 CEILING-MOUNTED FANS

- A. Housing: Steel, lined with acoustical insulation.
- B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.
- C. Back-draft damper: Integral.
- D. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
 - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 4. Motion Sensor: Motion detector with adjustable shutoff timer.
 - 5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
 - 6. Filter: Washable aluminum to fit between fan and grille.
 - 7. Isolation: Rubber-in-shear vibration isolators.
 - 8. Manufacturer's standard roof jack or wall cap, and transition fittings.

3.3 IN-LINE CABINET FANS

- A. Description: Square in-line centrifugal fans.
- B. Housing:
 - 1. Housing Material: Reinforced steel.
 - 2. Housing Coating: Hot-dip galvanized.
 - 3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream; factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance quality and vibration levels for fans.
- F. Motor Enclosure: Open, dripproof type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be provided at the scheduled voltage.
- G. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 3. Companion Flanges: For inlet and outlet duct connections.
 - 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
 - 6. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

3.4 CENTRIFUGAL IN-LINE FANS

- A. Description: Square in-line centrifugal fans.
- B. Housing:
 - 1. Housing Material: Reinforced steel.
 - 2. Housing Coating: Hot-dip galvanized.
 - 3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service

door.

- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.
- F. Motor Enclosure: Totally enclosed, fan cooled NEMA Design B motor with Class B insulation. Motor shall be rated for continuous duty and furnished at the scheduled voltage and phase.
- G. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 3. Companion Flanges: For inlet and outlet duct connections.
 - 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
 - 6. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

3.5 CENTRIFUGAL ROOF DOWNBLAST FANS

- A. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 - 6. Fan and motor isolated from exhaust airstream.
- D. Accessories:
 - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted

3. outside fan housing, factory wired through an internal aluminum conduit.
Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
 6. Spark-resistant, all-aluminum wheel construction.
 7. Mounting Pedestal: Galvanized steel with removable access panel.
- E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange. Manufactured to accommodate roof slope.
 2. Overall Height: 18 inches.
 3. Sound Curb: Curb with sound-absorbing insulation.
 4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
 5. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares.
 6. Pitch Mounting: Manufacture curb for roof slope.
 7. Metal Liner: Galvanized steel.
- 3.6 CENTRIFUGAL ROOF UPBLAST FANS
- A. Configuration: Centrifugal roof upblast ventilator.
- B. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
1. Resiliently mounted to housing.
 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 6. Fan and motor isolated from exhaust airstream.
- E. Accessories:
1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from

- 100 to less than 50 percent.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
 6. Spark-resistant, all-aluminum wheel construction.
- F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange. Manufactured to accommodate roof slope.

3.7 CENTRIFUGAL ROOF KITCHEN HOOD VENTILATOR

- A. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 2. Provide grease collector.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:
1. Resiliently mounted to housing.
 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 6. Fan and motor isolated from exhaust airstream.
- D. Accessories:
1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 3. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric

6. actuator; wired to close when fan stops.
Spark-resistant, all-aluminum wheel construction.
 7. Mounting Pedestal: Galvanized steel with removable access panel.
 8. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.
- E. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange manufactured to accommodate roof slope.
 2. Overall Height: 18 inches.
 3. Hinged sub-base to provide access to damper or as cleanout for grease applications.
 4. Pitch Mounting: Manufacture curb for roof slope.
 5. Metal Liner: Galvanized steel.
 6. Mounting Pedestal: Galvanized steel with removable access panel.
 7. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
 8. NFPA 96 code requirements for commercial cooking operations.
 9. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

3.8 CENTRIFUGAL SIDEWALL FANS

- A. Configuration: Centrifugal sidewall ventilator.
- B. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
1. Resiliently mounted to housing.
 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 6. Fan and motor isolated from exhaust airstream.
- E. Accessories:
1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.

3. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Wall Mount Adapter: Attach wall-mounted fan to wall.

3.9 SIDEWALL PROPELLER FANS

- A. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.
- B. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- C. Fan Drive:
 1. Belt drive.
 2. Resiliently mounted to housing.
 3. Statically and dynamically balanced.
 4. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 5. Extend grease fitting to accessible location outside of unit.
 6. Service Factor Based on Fan Motor Size: 1.4.
 7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L(50) of 200,000 hours.
 9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 10. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 12. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- D. Accessories:
 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
 3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
 4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 5. Wall Sleeve: Galvanized steel to match fan and accessory size.
 6. Weathershield Hood: Galvanized steel to match fan and accessory size.

3.10 UPBLAST PROPELLER ROOF EXHAUST FANS

- A. Configuration: Upblast propeller ventilator.
- B. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
 - 1. Damper Rods: Steel with bronze bearings.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades; sparkproof construction.
- D. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Weatherproof housing of same material as fan housing.
 - 3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
 - 5. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 6. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 - 7. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.
- E. Accessories:
 - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 3. Inspection Door: Hinged.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
 - 6. Extended Lubrication Lines.
- F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.

3.11 AXIAL ROOF VENTILATORS

- A. Housing: Heavy-gauge, removable, spun-aluminum dome top and outlet baffle; square, one-piece, hinged, aluminum base.
- B. Fan Wheel: Aluminum hub and blades.

C. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.

D. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Stack hood with built-in backdraft dampers.
6. Extended lubrication lines.

E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 18 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares.

3.12 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3.13 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified

Ratings Seal.

- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 4 - EXECUTION

4.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with zinc-plated hardware.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 1 inch.
- E. Install units with clearances for service and maintenance.
- F. Label units with engraved aluminum nameplate. Nameplate shall include the make, model, date of installation, design CFM and static pressure.
- G. For fans installed on metal roofs, coordinate roof curb with the shape profiles of the roof panels. Provide custom color prefinished galvalume exterior cladding on the exterior or the roof curb. Coordinate color of the custom-colored cladding with the Architect.

4.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

4.3 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

4.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

4.5 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

4.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain ventilator fans.

END OF SECTION 23 34 23

SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES



PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Louver face diffusers.
 - 3. Linear bar diffusers.
 - 4. Linear slot diffusers.
 - 5. Adjustable bar, registers and grilles
 - 6. Eggcrate Grille with Filter Frames

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.
 - a. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products; a Mestek company.
 - ii. Krueger.
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries.
 - vi. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: White baked enamel, unless noted otherwise.
5. Face Size: See Plans.
6. Face Style: Three cone.
7. Mounting: Surface T-bar
8. Pattern: Fixed
9. Dampers: Radial opposed blade.

B. Louver Face Diffuser

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products; a Mestek company.
 - ii. METALAIRE, Inc.
 - iii. Nailor Industries Inc.
 - iv. Price Industries.
 - v. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Custom color selected by Architect.
5. Face Size: See Plans.
6. Mounting: Surface and T-bar.
7. Pattern: Four-way core style.
8. Dampers: Radial opposed blade.
9. Accessories:
 - a. Square to round neck adaptor.
 - b. Adjustable pattern vanes.
 - c. Throw reducing vanes.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products; a Mestek company.
 - ii. Krueger.
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries.
 - vi. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: White baked enamel, unless noted otherwise.
5. Wide Core Spacing Arrangement: 1/8-inch thick blades spaced 1/2 inch apart, zero 15-degree deflection.
6. Wide Core Spacing Arrangement: 3/16-inch thick blades spaced 1/2 inch apart, zero 15 or 30-degree deflection.
7. Narrow Core Spacing Arrangement: 1/8-inch thick blades spaced 1/4 inch apart, zero 15degree deflection.
8. One-Way Deflection Vanes: Extruded construction fixed louvers with removable core.
9. Frame: 1- inches wide.
10. Mounting: Concealed bracket.
11. Damper Type: Adjustable opposed-blade assembly.

B. Linear Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products; a Mestek company.
 - ii. Krueger.
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries.
 - vi. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Aluminum, insulated.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish: White baked enamel, unless noted otherwise.
6. Number of Slots: as required or noted.
7. Length: See Plans.

8. Accessories: Plaster frame or T-bar slot.

2.3 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products; a Mestek company.
 - ii. Krueger.
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries.
 - vi. Titus.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 3/4 inches apart.
5. Core Construction: Removable.
6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7. Frame: 1 inch wide.
8. Mounting Frame: Filter
9. Mounting: Countersunk screw or Lay in.
10. Damper Type: Adjustable opposed blade.
11. Accessories:
 - a. Front-blade gang operator.

B. Adjustable Bar Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products; a Mestek company.
 - ii. Krueger.
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries.
 - vi. Titus.
2. Material: Aluminum
3. Finish: White baked enamel, unless noted otherwise.
4. Face Blade Arrangement: Horizontal spaced 3/4 inches apart.
5. Core Construction: Integral
6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7. Frame: 1 inch wide.
8. Mounting: Countersunk screw or Lay in.

C. Eggcrate Grille with Filter Frames:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products
 - ii. Krueger
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries
 - vi. Titus
2. Material: Aluminum Grid and border with filter frame
3. Finish: White baked enamel, unless noted otherwise. Finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.
4. Mounting: Countersunk screw
5. Return grilles must provide a free area of at least 90%.
6. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch and shall have countersunk screw holes for a neat appearance.
7. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.
8. Aluminum grid shall be ½ x ½ x ½ inch. Grille shall be provided with a filter frame for a standard 1-inch filter to fit the specified duct size.
9. The manufacturer shall provide published performance data for the grille.
10. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 43 16 - AIR IONIZATION SYSTEMS



PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Performance and design criteria for air ionization systems.

1.3 DEFINITIONS

- A. NPBI - Needlepoint bipolar ionization system

1.4 ACTION SUBMITTALS

- A. Product Data: For each product. Include dimensions; operating characteristics; required clearances and access; rated capacity; fire classification; furnished specialties; and accessories as indicated.
- B. Product Data: Manufacturer's technical product data for ionization systems.
 1. Schedule of ionization systems indicating unit designation, number of each type required for each unit/application.
 2. Data sheet for each ionization system type, and accessories furnished. Indicate construction, sizes, and mounting details.
 3. Ion performance data for each type of ionization device furnished.
 4. Product drawings detailing physical, electrical and control requirements.
 5. Proof of Compliance with UL-2998: Environmental Claim Validation Procedure for Zero Ozone Emissions from Air Cleaners
 - a. Certificates must be listed on either of the following websites.
 - i. <https://spot.ul.com/>.
 - ii. <https://sustainabilitydirectory.intertek.com/home>.
- C. Operating and Maintenance Data:
 1. Submit O&M data and recommended spare parts lists. Include 10 years of operations and energy costs.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Ion performance for each type of Needlepoint Bipolar Ionization (NPBI™) system as detailed in this specification.
- B. Field Quality-Control Reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of Needlepoint Bipolar Ionization (NPBI™) system.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company who specializes in manufacturing products specified in this section. Documented Experience: 10 years.
 - 1. A qualified representative of the manufacturer shall be available to inspect the installation of the air ionization system to ensure installation in accordance with manufacturer's recommendation.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery: In factory fabricated shipping containers.
 - 1. Identify on outside of container type of product and location to be installed.
 - 2. Avoid crushing or bending.
- B. Storage: In original cartons and protect from weather and construction work traffic.
 - 1. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.9 WARRANTY

- A. Equipment is warranted by the manufacturer against defects in material and workmanship for a period of one year after shipment.
 - 1. Warranty will be for full replacement within one-year period and not prorated.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Provide Products manufactured by the following:
 - 1. Global Plasma Solutions.
- B. Substitutions:
 - 1. It is the responsibility of manufactures to confirm non-infringement on intellectual property.

2.2 PERFORMANCE AND DESIGN CRITERIA FOR AIR IONIZATION SYSTEMS

- A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Needlepoint Bipolar Ionization (NPBI™) system with output as described here within.
- B. Project Design:
 - 1. If using ASHRAE Standard 62.1 - IAQP: IAQ Procedure requires a qualified Designer or Engineer to provide Indoor Air Quality calculations using formulas within ASHRAE Standard 62.1 to validate acceptable indoor air quality at the quantity of outside air scheduled with the technology submitted.
 - 2. Unacceptable Technologies:
 - a. Powered particulate filters.
 - b. Polarized media filter.
 - c. Uni-polar ion generators.
 - d. "Plasma" particulate filters.
 - e. High-powered ionization devices.
 - f. Ozone generators.
 - g. Photocatalytic Oxidation (PCO) products.
 - h. Dry hydrogen peroxide products.
- C. Maximum Ozone Emissions per UL 2998:
 - 1. Not Acceptable: Products not certified to UL2998 - Environmental Claim Validation Procedure for Zero Ozone Emissions.
- D. All devices shall be listed on the UL SPOT environmental claim validation website, or the Intertek Sustainability Certification Directory website, proving compliance to UL 2998.
 - 1. Test result reports must be available from Manufacturer upon request.
 - 2. Not Acceptable: Products not listed on either of these websites are not acceptable.
- E. Humidity: Ionization devices do not require preheat protection when relative humidity of entering air exceeds 85 percent. Relative humidity from 0 to 100 percent, condensing, will not cause damage, deterioration, or dangerous conditions within the air ionization system.
- F. Ionization Requirements: Installed as indicated on the Drawings or as specified.
 - 1. Ionization Output: Positive and negative ions shall be produced. Unipolar ionization devices are not acceptable. Output varies from product to product. See specific product specification information for total ion output.
 - a. Ion Output: Ions per cubic centimeter when tested at 1 inch (25 mm) from the ionization system.
 - i. Manufacturers showing ion output in ions/cc/sec must convert to ions/cc as measured 1 inch (25 mm) from the electrodes without airflow and provide that data during the submittal process. Ion meters measure in ions/cc not ions/cc/sec and these values are required for field verification during commissioning.
- G. NPBI™ Components:

1. Tested by UL or Intertek proving conformance to UL 2998 Third Edition (2020) ozone standard when tested using UL 867 Fifth Edition (2011) methodology. Testing must be large chamber environment testing and peak ozone test for electronic devices in accordance with the standard.
 - a. Submit independent UL 867 test data with ozone results to Engineer of Record during submittal process.
 - b. Components achieving UL 867 prior to December 21, 2007, were not tested with the ozone amendment and are not acceptable for consideration.
 - c. Increasing interior ion concentration levels, both positive and negative collectively, to a minimum of 2000 ions/cc measured 5 ft (1524 mm) from floor where air is delivered from the duct system.
 - d. Produce positive and negative ions.
 - i. Not Acceptable: Uni-polar ion devices.
 - e. Air exchange rates may vary through the full operating range of a constant volume or variable air volume (VAV) system. The quantity of air exchange must not be increased due to requirements of the air ionization system.
 - f. Velocity Profile: Maintain minimum air velocity of 300 feet per minute (FPM). Air ionization devices do not have maximum velocity profiles.

H. Ion Systems: General.

1. Ionization Devices Enclosures: Non-metallic materials for corrosion prevention and thermal bridging.
2. UL 2998 Environmental Claim Validation Procedure for Zero Ozone Emissions from Air Cleaners certification is required. No exceptions.
3. Integral Alarm Dry Contacts: For connection to BAS to prove ionization system is receiving adequate input power.
4. Capable of operating in 100 percent relative humidity conditions, without damage.
5. No maximum velocity limitation.
6. Mounting: Magnets or self-tapping sheet metal screws.

I. Design Requirements for Non-Coil Cleaning Installations:

1. Installations must include the required number of electrodes and power generators sized to the air handling equipment capacity.
2. NPBI™ Electrodes: Made from carbon fiber to prevent oxidation over time. Carbon fiber clusters must contain a minimum of 45,000 needles.
 - a. Not Acceptable: titanium, stainless or any other metal.
 - b. Not Acceptable: Bipolar ionization tubes manufactured of glass, composite, mica, or similar dielectric materials.
 - c. Energize when main unit disconnect is turned on and fan is operating.
 - i. Not Acceptable: Ionization systems requiring mechanical air pressure switches to cycle electrodes when fan is operating.
 - d. Electrode Pair: Provide electrodes to generate both positive and negative ions.
 - e. Mechanical friction auto-cleaning systems to ensure needle tips are properly cleaned.
 - i. Not Acceptable: Systems using vibration, high frequency or plunging action as a means of auto-cleaning

3. Multi-Voltage Input: **[24V to 240V AC or DC]**
 4. Magnets for mounting to fan inlet.
 5. Auto-Cleaning Mechanisms: Mechanical friction auto-cleaning systems to ensure needle tips are properly cleaned.
 - a. Not Acceptable: Systems using vibration, high frequency or plunging action as a means of auto-cleaning.
- J. Design Requirements: GPS-iMOD®
- 1.
 2. NPBI™ Electrodes: Made from carbon fiber to prevent oxidation over time. Not Acceptable: titanium, stainless or any other metal.
 - a. Provided in 6 inch (152 mm) sections for field assembly by installer. Assemble such that entire finned width of the coil is covered.
 - b. One modular ionization bar for every 5 ft (1524 mm) of coil height.
 - c. Electrode Spacing: 0.5 inch (13 mm) apart.
 - i. Not Acceptable: Ionization Bars with ion output spaced greater than 1 inch (25 mm) apart.
 - d. Output: A minimum of 140M ions/cc per inch of bar measured 1 inch (25 mm) from carbon fiber brushes.
 - e. Ionization Bars: Provided with separate power supply capable of powering up to 4 ionization bars requiring no more than 20 watts of power up to a total connected bar length of 48 ft (14.63 m). Single bar length limit is 12 feet.
 - i. The ionization bars and power supply to be alternating current output.
 - ii. Provided with an on/off switch with LED light.
 - iii. BAS interface capable using dry alarm contacts.
 - f. AC Output Power Supply: Accept 24 VAC, 110 VAC or 208 to 240VAC input.
 3. NEMA 4 Enclosure: For external power mounts.
- K. Electrical Requirements: Wiring, conduit, and junction boxes.
1. Installed within housing plenums in accordance with NEC NFPA 70.
 2. NPBI™ Units: Accept electrical service of 24 VAC to 240 VAC, universal 2 wire input, 1 phase, 50/60 Hz.
 3. Coordinate electrical requirements with air ionization device manufacturer during submittals.
- L. Control Requirements:
1. NPBI™ Devices:
 - a. Internal short circuit protection.
 - b. Overload protection.
 - c. Automatic fault reset circuit breakers.
 - d. Capable of interfacing with the BAS system.
 - i. Provide dry contacts to prove the unit is receiving adequate input power.
 - e. Not Acceptable: Manual fuses.
 2. Ionization output: Varies as airflow velocity changes.

3. Mount and wire NPBI™ devices within air handling units specified or as shown or the Drawings. Follow manufacturer IOM instructions during installation.

2.3 NON-AUTO-CLEANING - AC VOLTAGE OUTPUT

- A. Product: GPS-iMOD®. Modular Bipolar Ionization Device. Made of composite and carbon fiber. Handles 50 to 250 CFM per inch of bar. Voltage selector switch, illuminated On/Off switch, operation status LED, six HV output ports, integral Building Automation System (BAS) alarm contacts, auxiliary terminals for connection of an optional GPS-iDETECT-P™ Ion Sensor. GPS-iMOD® Bar: 6 inch (152 mm) Sections, nine brushes per section, up to 144 inch (3658 mm) total length, with rare earth magnets for easy spacing and mounting.
 1. Electrical Listings: UL, cUL.
 2. Standards Compliance: UL 2998, UL 867, IAQP, OSHPD Seismic (OSP), CE, CARB.
 3. Input Voltage: 24/120/208-240 VAC.
 4. Amps: 0.500 A/0.120 A/0.065 A.
 5. Frequency: 50/60 Hz.
 6. Output Voltage: 5 kV RMS.
 7. Output Frequency: 50/60 Hz.
 8. Total Ion Output: Greater than 140M ions/cc per inch of bar.
 9. Temperature Range: -40 to 140 degrees F (-40 to 60 degrees C).
 10. Relative Humidity Range: 0 to 100 percent.
 11. Power Entry: UL Listed, line cord with 3-prong plug.
 12. Power Unit Dimensions (LxWxH): 9.00 x 3.25 x 4.75 inches (229 x 83 x 121 mm).
 13. Ionizer Bar Dimensions (HxW): 1.6 x 0.75 inches (41 x 19 mm).
 - a. Length per Section: 6.0 inches (152 mm). Plus 1.2 inches (30.5 mm).
 - b. Maximum Length: 144 inches (3658 mm)
 14. Power Unit Weight: 4.63 lbs (2.1 kg).
 15. Ionizer Bar Weight: 0.24 lbs (113 grams) per 6.0 inch (152 mm) section.
 16. Install locations: Duct work, in the air flow, between evaporator coil and filter.
 17. Power Requirements: Operate from 24 VAC to 240 VAC without the use of an external power supply or transformer.
 - a. Primary voltage may vary in range of 24 to 240 VAC.

2.4 NON-AUTO-CLEANING - DC VOLTAGE OUTPUT

- A. Product: GPS-iRIB®-18, Flexible needlepoint bipolar ionization strip. Made from flexible chemical, heat, and cold resistant inert polyimide material. Contains a circuit with carbon fiber ion emitters soldered into the circuit traces. Designed for up to 3,200 CFM or 8 tons. Fixed lengths of 18 inches (457 mm), for use up to 36 inch applications, operation status LED, integral Building Automation System (BAS) alarm contacts, hook and loop tape for easy installation, and voltage input range of 110 to 240 VAC.
 1. Electrical Listings: UL, cUL.
 2. Compliance and Certifications: UL 2998, UL 867, IAQP, CE, CARB.
 3. Input Voltage: 110 to 240 VAC.
 4. Power Consumption: 5 Watts.
 5. Frequency: 50/60 Hz.

6. Output Voltage: 2 kV.
 7. Total Ion Output: Greater than 35 M ions/cc per ft.
 8. Airflow Capacity: 0 to 3,200 CFM or 8 tons.
 9. Alarm Contact Rating: 250 VAC / 1A, N.O. “dry” contact.
 10. Temperature Range: -40 to 140 degrees F (-40 to 60 degrees C).
 11. Relative Humidity Range: 0 to 100 percent.
 12. Power Unit Dimensions (WxLxH): 1.75 x 3.75 x 1.00 inches (44 x 95 x 25 mm).
 13. Ionizer Strip Dimensions (WxLxH): 1.50 x 18.00 x 0.05 inches (38 x 457 x 1.3 mm).
 14. Combined Weight: 0.50 lbs (227 grams).
 15. Install locations: In the air flow.
 16. Power Requirements: Operate from 24 VAC to 240 VAC without the use of an external power supply or transformer.
 - a. Primary voltage may vary in range of 24 to 240 VAC.
 - b. The high voltage output to be regulated to less than 1 percent variance.
- B. Product: GPS-iRIB®-36, Flexible needlepoint bipolar ionization strip. Made from flexible chemical, heat, and cold resistant inert polyimide material. Contains a circuit with carbon fiber ion emitters soldered into the circuit traces. Designed for up to 3,200 CFM or 8 tons. Fixed lengths of 36 inches (914 mm), for applications over 36 inches, operation status LED, integral Building Automation System (BAS) alarm contacts, hook and loop tape for easy installation, and voltage input range of 110 to 240 VAC.
1. Electrical Listings: UL, cUL.
 2. Compliance and Certifications: UL 2998, UL 867, IAQP, CE, CARB.
 3. Input Voltage: 110 to 240 VAC.
 4. Power Consumption: 5 Watts.
 5. Frequency: 50/60 Hz.
 6. Output Voltage: 2 kV.
 7. Total Ion Output: Greater than 35 M ions/cc per ft.
 8. Airflow Capacity: 0 to 3,200 CFM or 8 tons.
 9. Alarm Contact Rating: 250 VAC / 1A, N.O. “dry” contact.
 10. Temperature Range: -40 to 140 degrees F (-40 to 60 degrees C).
 11. Relative Humidity Range: 0 to 100 percent.
 12. Power Unit Dimensions (WxLxH): 1.75 x 3.75 x 1.00 inches (44 x 95 x 25 mm).
 13. Ionizer Strip Dimensions (WxLxH): 1.50 x 36.00 x 0.05 inches (38 x 914 x 1.3 mm).
 14. Combined Weight: 0.50 lbs (227 grams).
 15. Install locations: In the air flow.
 16. Power Requirements: Operate from 24 VAC to 240 VAC without the use of an external power supply or transformer.
 - a. Primary voltage may vary in range of 24 to 240 VAC.
 - b. The high voltage output to be regulated to less than 1 percent variance.
- C. Product: **[GPS-FC-3-BAS, 24 VAC] [GPS-FC-3T-BAS, 110 to 240 VAC]** NPBI™ bipolar ionization device with BAS alarm contacts. Designed for up to 3,200 CFM or 8 tons. Carbon fiber brush emitters, operation status LED, integral Building Automation System (BAS) alarm contacts, mounting tabs, positive and negative ion output.
1. Electrical Listings: UL.
 2. Standards Compliance: UL 2998, IAQP, CE, CARB.

3. Input Voltage: [24 VAC] [110 to 240 VAC].
4. Power Consumption: 1.2 Watts.
5. Frequency: 50/60 HZ.
6. Total Ion Output: Greater than 350 M ions/cc.
7. Airflow Capacity: 0 - 3,200 CFM or 8 tons.
8. Temperature Range: -20 to 140 degrees F (-28.9 to 60 degrees C).
9. Relative Humidity Range: 0-100 percent.
10. Unit Dimensions (LxHxD): 2.6 x 1.9 x 1.3 inches (66 x 48 x 33 mm).
11. Unit Weight: 0.23 lbs (104 grams).
12. Alarm Contact Rating: 24 VAC, 0.1 A, N.O. "dry" contacts.
13. Install locations: Fan Inlet, in the air flow, zoner diffuser.
14. Power Requirements: Operate from 24 VAC to 240 VAC without the use of an external power supply or transformer.
 - a. Primary voltage may vary in range of 24 to 240 VAC.
 - b. The high voltage output to be regulated to less than 1 percent variance.

2.5 AUTO-CLEANING – DC VOLTAGE OUTPUT

- A. Product: GPS-FC24™-AC, Auto-Cleaning Needlepoint Bipolar Ionization System. Handles up to 2,400 CFM or 6 tons. Composite construction allows for mounting in corrosive environments. Universal voltage input, in line On/Off switch, programmable autocleaning cycle, operation status LED, integral Building Automation System (BAS) alarm contacts, magnets for ease of installation and replaceable carbon fiber brush emitters.

1. Electrical Listings: UL, cUL.
2. Compliance and Certifications: UL 2998, UL 867, IAQP, CE, CARB.
3. Input Voltage: 24 to 240 VAC.
4. Amps: Operating: 0.170 to 0.017 A. Cleaning Cycle: 0.33 to 0.03 A.
5. Power: Operating: 4 watts. Cleaning Cycle: 8 watts.
6. Frequency: 50/60 Hz.
7. Total Ion Output: Greater than 300M ions/cc.
8. Airflow Capacity: 0 to 2,400 CFM or up to 6 tons.
9. Temperature Range: -20 to 140 degrees F (-29 to 60 degrees C).
10. Relative Humidity Range: 0 to 100 percent.
11. Ionizer Unit Dimensions (LxWxH): 7.9 x 1.1 x 5.0 inches (200 x 28 x 127 mm).
12. Ionizer Unit Weight: 1.25 lbs. (567 grams).
13. Alarm Contact Rating: 250 VAC, 1A, N.O. "dry" contact.
14. Install locations: Fan inlet, In the air flow, zone diffuser.
15. Power Requirements: Operate from 24 VAC to 240 VAC without the use of an external power supply or transformer.
 - a. Primary voltage may vary in range of 24 to 240 VAC.
 - b. The high voltage output to be regulated to less than 1 percent variance.

- B. Product: GPS-FC48™-AC, Auto-Cleaning Needlepoint Bipolar Ionization System. Handles up to 4,800 CFM or 12 tons. Composite construction allows for mounting in corrosive environments. Universal voltage input, in-line On/Off switch, programmable autocleaning cycle, operation status LED, integral Building Automation System (BAS) alarm contacts, magnets for ease of installation and replaceable carbon fiber brush emitters.

1. Electrical Listings: UL, cUL.
2. Compliance and Certifications: UL 867, UL 2998, IAQP, CE, CARB.

3. Input Voltage: 24 to 240V AC/DC.
 4. Amps: 0.41 to 0.041 A.
 5. Power Consumption: 10 Watts.
 6. Frequency: 50/60 HZ.
 7. Total Ion Output: Greater than 400 million ions/cc.
 8. Airflow Capacity: 0 to 4,800 CFM or up to 12 tons
 9. Temperature Range: -20 to 140 degrees F (-29 to 60 degrees C).
 10. Relative Humidity Range: 0 to 100 percent.
 11. Unit Dimensions (LxWXH): 11.1 x 1.84 x 3.52 inches (282 x 47 x 89 mm).
 12. Weight: 1.32 lbs (600 grams).
 13. Alarm Contact Rating: 250VAC, 1A, N.O. "dry" contact.
 14. Install locations: Fan inlet, in the air flow, zone diffuser.
 15. Power Requirements: Operate from 24 VAC to 240 VAC without the use of an external power supply or transformer.
 - a. Primary voltage may vary in range of 24 to 240 VAC.
 - b. The high voltage output to be regulated to less than 1 percent variance.
- C. Product: GPS-DM48™-AC. Auto-Cleaning, Duct Mounted, needlepoint bipolar ionization system. Handles up to 4,800 CFM or 12 tons. Universal voltage input, integral display, programmable auto-cleaning cycle, operation status display, integral Building Automation System (BAS) alarm contacts, 3/4 quick turn duct adapter, 6 ft of watertight flexible conduit, and carbon fiber brush emitters.
1. Electric Approvals: UL, cUL.
 2. Compliance and Certifications: UL 867, UL 2998, IAQP, CE, CARB.
 3. Input Voltage: 24 to 240 V AC/DC.
 4. Power Consumption: 12 Watts.
 5. Frequency: 50/60HZ.
 6. Total Ion Output: Greater than 400M ions/cc.
 7. Airflow Capacity: 0 to 4,800 CFM or up to 12 tons.
 8. Temperature Range: -20 to 140 degrees F (-29 to 60 degrees C).
 9. Relative Humidity Range: 0 to 100 percent.
 10. Unit Dimensions: 3.75 inches (95 mm) diameter. Length: 7 inches (178 mm).
 11. Weight: 2.31 lbs (1.048 kg).
 12. Alarm Contact Rating: 250 VAC, 1A, N.O. "dry" contact.
 13. Install locations: In duct work, in the air flow.
 14. Includes weathertight seals for external duct mounting.
 15. Power Requirements: Operate from 24 VAC to 240 VAC without the use of an external power supply or transformer.
 - a. Primary voltage may vary in range of 24 to 240 VAC.

PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor is responsible for maintaining air systems until owner accepts the building (Owner Acceptance).

3.2 INSTALLATION, GENERAL

- A. Needlepoint Bipolar Ionization (NPBI™) Systems:

1. Assemble and install equipment in a workman like manner to the satisfaction of the Engineer of Record, and Owner's representative.
2. Damaged or faulty components must be replaced, at no cost additional cost to the owner.
3. Protect components from dust and damage daily throughout construction.

3.3 INSTALLATION, GPS-iMOD® - AC VOLTAGE OUTPUT

A. Product: GPS-iMOD®, Modular Air Ionization System.

1. Installation Location: Downstream of a MERV 6, or higher, 30 percent particulate filter to prevent unnecessary build-up of particulate on the carbon fiber needle tips.
 - a. Mounting Location:
 - i. Between the particulate filter and cooling coil.
2. Mechanical Installation:
 - a. A quantity of 1 GPS-iMOD® bar assembly on each coil up to 60 inches (1524 mm) in height. The bars should be spaced a maximum of 60 inches (1524 mm) apart to get optimal ionization coverage on coils.
 - i. Install such that the GPS-iMOD® bar covers the entire finned-width of the coil to the nearest 6 inches (152 mm) without exceeding the finned-width of the coil.
 - ii. Follow manufacturers published installation instructions.

3.4 INSTALLATION - NON-AUTO-CLEANING - DC VOLTAGE OUTPUT

A. Product: GPS-iRIB®-18, Flexible Needlepoint Bipolar Ionization Strip; 18 inches (457 mm) long.

1. Installation Location: Ductless Mini-Split and PTAC Mounting and Wiring.
2. Mechanical Installation: Follow manufacturers published installation instructions

B. Product: GPS-iRIB®-36, Flexible Needlepoint Bipolar Ionization Strip; 36 inches (914 mm) long.

1. Installation Location: Ductless Mini-Split and PTAC Mounting and Wiring.
2. Mechanical Installation: Follow manufacturers published installation instructions

C. Product: [GPS-FC-3-BAS] [GPS-FC-3T-BAS], NPBI™ Air Ionization System.

1. Installation Location: Downstream from filter to prevent build-up of particulates on the ion emitters.
 - a. Locations to mount in preferred order.
 - i. Downstream from filter and blower, prior to cooling coil.
 - ii. Downstream from filter, blower, and coil.
 - iii. Prior to filter is not recommended. Particulate build up will be greater prior to filter. Cleaning will need to be done more frequently.
2. Mechanical Installation: Select a location for installation. Unit needs to be perpendicular to air flow. Mount so ion emitters are exposed to airstream. Air should flow past ion emitters like a football through goal posts.
 - a. Ideal Locations:

- i. Typical Split Systems: Blower inlet on blower housing, the side opposite the blower motor. Housings should be so ion emitters extend slightly above side of blower housing.
- ii. Ceiling Cassette Units: On fan side of protective screen / grille.
- iii. Mini Split Systems: After filter and behind coil. Typically mounted to wall plate.
- iv. Ducted Modules: On intake side after filter between the blower housings.
- b. Follow manufacturers published installation instructions.

3.5 INSTALLATION, AUTO-CLEANING - DC VOLTAGE OUTPUT

A. Product: GPS-FC48™-AC, NPBI™ Auto-Cleaning Air Ionization System.

- 1. Installation Locations to mount in preferred order.
 - a. Downstream from filter.
 - b. Blower inlet on blower housing, the side opposite the blower motor.
 - c. Downstream from filter and blower, prior to cooling coil.
 - d. Downstream from filter, blower, and coil.
 - e. Prior to filter is not recommended. Particulate build up will be greater prior to filter. Cleaning will need to be done more frequently.
- 2. Alternate Mounting Locations: Supply or return air duct after system filter.
- 3. Mechanical Installation:
 - a. Follow manufacturers published installation instructions.

B. Product: GPS-FC24™-AC, NPBI™, Auto-Cleaning Air Ionization System.

- 1. Installation Locations to mount in preferred order.
 - a. Downstream from filter.
 - b. Blower inlet on blower housing, the side opposite the blower motor.
 - c. Downstream from filter and blower, prior to cooling coil.
 - d. Downstream from filter, blower, and coil.
 - e. Prior to filter is not recommended. Particulate build up will be greater prior to filter. Cleaning will need to be done more frequently.
 - f. Ductless Mini-Split Ceiling Cassette Applications: Mount unit to fan inlet. The emitter brushes should be no closer than 2 inches (51 mm) from any wiring or metal objects.
- 2. Mechanical Installation:
 - a. Follow manufacturers published installation instructions

C. Product: GPS-DM48™-AC, NPBI™ Auto-Cleaning Air Ionization System.

- 1. Installation Location: Supply air duct.
 - a. Alternate Mounting Location: Return air duct after the filter.
 - i. The duct must have a depth greater than 8 inches (203 mm) for unit to operate properly.
 - ii. Weatherproof housing allows mounting indoors or outdoors.
- 2. Mechanical Installation:
 - a. Follow manufacturers published installation instructions

3.6 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

- A. Comply with NECA 1.
- B. Field Inspection: Coordinate field inspection in accordance with the "Quality Assurance" Article in PART 1 of this specification and appropriate sections in Division 01.

3.7 TESTING

- A. Provide the manufacturers recommended high voltage verification electrical test.

3.8 PROTECTION

- A. Protect installed products and accessories from damage during construction.

END OF SECTION 23 43 16



SECTION 23 80 00 - AIR CONDITIONING, HEATING AND VENTILATING

1.1 GENERAL

- A. The air conditioning system, in general, shall be for the entire building, providing cooling and dehumidification in summer and heating in winter. A constant amount of outside air shall be taken into the system and all air shall be filtered.

1.2 HIGH EFFICIENCY CONDENSING UNIT- OUTDOOR SECTION

- A. Furnish and install high-efficiency, air-cooled top discharge condensing unit where shown and with capacities scheduled. UNIT SHALL BE COMPLETELY FACTORY ASSEMBLED, PRE-CHARGED AND TESTED, AND SHALL BE SUPPLIED FROM THE FACTORY WITH ALL FEATURES LISTED BELOW.
- B. Condenser coil shall be constructed of aluminum fins mechanically bonded to an aluminum coil and shall be protected with stamped louvered panels on outside of unit.
- C. Condenser fan shall be propeller type, direct driven. Motor shall have inherent protection and be of the permanently lubricated type, resiliently mounted. Fans shall be complete with safety guards.
- D. Compressor shall be a single speed serviceable hermetic or sealed hermetic design complete with crankcase heater and external spring isolators and compressors, and shall have a 5-year warranty. Unit shall be equipped with time delay to prevent compressor from starting within five minutes of "off" time.
- E. All controls shall be factory wired and shall consist of condenser fan overload devices, hard start kit (single phase only), internal pressure relief valve, filter dryers, pressure taps for refrigerant check, quick connect refrigerant couplings and liquid and suction line service valves. Unit shall also be furnished with outdoor expansion valve or metering valve and check valve, switch-over valve, time and temperature defrost control system, "thermister" outdoor temperature sensor and an evaporator defrost control kit to permit the cooling system to operate down to 30oF outdoor temperature.
- F. Casing shall be fully weatherproof for outdoor installation and shall be bonderized steel with baked enamel finish. Panels shall be removable to provide access for servicing. Unit shall be set in place on rubber mounting pads.
- G. Contractor shall advise the Electrical Contractor of the manufacturer's recommended fuse size if different from that specified on the Electrical Drawings. Mechanical Contractor shall pay any additional costs required to change fuse sizes.
- H. Units shall be Lennox or prior approved equivalent.

1.3 HIGH EFFICIENCY AIR CONDITIONING UNIT- INDOOR SECTION

- A. Furnish and install vertical discharge/bottom return, or horizontal type (as indicated on plans) air conditioning unit of size, type and capacities as scheduled. Units shall be Lennox or prior approved equivalent.
- B. Units shall be complete with fan, multi-speed direct drive blower, motor, direct expansion cooling coil, low voltage control transformer, grease fittings, drain pan, etc. All units shall be factory insulated on the interior with not less than 3/4# density neoprene coated fiberglass cemented in place with waterproof adhesive.
- C. Each unit shall be mounted on a suitable base as indicated on plans or 18" (minimum) high painted angle iron base approved by the Engineer to allow for proper return air. Unit shall also be designed for continuous operation at the maximum rated static pressure. Fan capacities shall be rated with the fans in the units, and the horsepowers specified shall include all losses.
- D. Casings shall be suitable for operation at the pressures specified and constructed of bonderized steel.
- E. Cooling coils shall be of aluminum or copper and shall be tested at 400 psi air pressure. Cooling coil face velocity shall not exceed that guaranteed by manufacturer for no moisture carry-over.
- F. Electric strip heaters shall be as hereinafter specified and shall be mounted inside unit housing. Coordinate electric service to heaters and blower with Electrical Contractor. Heater and air unit shall be internally wired and fused to receive one electrical source of power.
- G. Filter shall be 1" thick, pleated, throw-way mounted in an accessible factory filter rack at unit.
- H. Contractor shall provide a new set of filters upon completion of project, to turn building over to Owner.
- I. If the manufacturer's equipment is not available internally wired to receive one source of power, necessary modifications to electric service shall be the responsibility of the equipment supplier. Any modifications required shall be submitted in writing ten (10) days prior to the bid date.

1.4 ELECTRIC STRIP HEATERS

- A. Electric strip heaters shall consist of open coils made from Grade "A" resistant wire insulated by floating ceramic bushings and supported in an aluminum steel frame.
- B. All terminal studs, nuts and washers shall be stainless steel, insulated with phenolic terminal bushings. Terminals shall be machine crimped to coils and heater shall be tested at 2000 volts before shipment. All voltages and phases shall be as scheduled.
- C. Heater shall be provided with built-in contactors, with one terminal block furnished for each circuit and separate contactors for each stage of heating. Heaters with air units supplying 2000 CFM or less shall be internally wired with air unit to receive one electric source of power.

- D. An automatic reset thermal cut-off shall be provided to break the heater load directly on over-temperature. In addition, provide manual reset thermal cut-off to break the heater load manually.
- E. Control circuit transformer shall be built into heater terminal box and sized to carry full contactor holding coil load.
- F. Heaters shall be listed by UL and shall be as manufactured by Chromalox, Electric Heaters, Inc., Industrial Engineering and Equipment Co., or an approved equivalent.
- G. Heater shall be equipped with built-in pressure type air flow switch. Heater shall be mounted inside unit housing.
- H. Where indicated on drawings, heaters in ductwork shall be provided with duct flanges. Outside of heater shall be wrapped with 2.33" thick fiberglass ductwrap with aluminum foil vapor barrier.

1.5 TESTING REFRIGERANT PIPING SYSTEMS

- A. Refrigerant lines shall be tested under 200 psi carbon dioxide pressure for 5 hours using soap suds at joints to test for leaks. Evacuate system and charge with refrigerant.

1.6 LABELING A/C UNITS:

- A. All indoor and outdoor a/c units shall be labeled with permanent laminated plate riveted to unit. Units shall be labeled as indicated in schedules. Plate shall be black with white unit numbers. Height of unit number shall be minimum of one (1) inch. Label shall also indicate area serviced by unit as noted in schedules. Height of letters shall be minimum of one-half (1/2) inch. Submit sample to Engineer for approval.

1.7 EMERGENCY DRAIN PAN (DX Equipment)

- A. All vertical split system air handling units shall be installed on 18"-24" high welded angle iron support in an emergency drain pan. Allow proper clearance for R.A. duct connection and removal of filters, etc.
- B. Drain pans shall be constructed of 20-gauge galvanized metal. Pan shall extend 4" beyond the edge of the unit. The sides of the pan shall be 4" high with drain connection located inside of the pan.
- C. Provide 3/4" Type "L" hard copper drain line with valve and pipe to floor drain in mechanical room.

1.8 VENTILATING SYSTEM

- A. This Contractor shall furnish and install all exhaust fans shown and scheduled on Plans. Fans shall be of the type indicated and shall be Cook, Greenheck, Acme, PennBarry, Broan, Twin City, ILG/American coolair, or approved equivalent.
- B. Ceiling mounted fans shall be complete with white ceiling mounted grille. Grille shall be removable to provide service access to fan, motor, etc.

END OF SECTION 23 80 00