MECHANICAL SPECIFICATIONS
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SECTION 23 00 00
MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to the Drawings, General Conditions, Supplementary Conditions, and Division 01 General Requirements.

B. This Section 23 00 00, applies specifically to all other Sections of Division 23.

C. Where requirements of this Section exceed those in other contract documents, Contractor shall comply with the requirements of this Section.

1.2 SCOPE OF WORK

A. Provide all labor, apparatus and materials that are required to provide a complete installation as indicated on the drawings and in the specifications, including that reasonably inferred for proper execution of this Division.

B. Provide cutting and patching as required for execution of work performed under this Division and not provided under other sections.

C. Repair or replace any damage to work of this Division, damage caused by leaks or breaks in systems of this Division, and damage caused by work of this Division including that to landscaping, paving or other items which are to remain in use.

D. Valves and trim not specifically indicated but required for proper functioning of equipment shall be furnished and installed by the craft furnishing the equipment.

E. Coordinate all utility requirements for equipment furnished by the mechanical sections of this division. Rough-in required systems and make final connections.

1.3 DEFINITIONS

A. Above Grade: Not buried in ground and not embedded in concrete slab on ground.

B. Below Grade: Buried in ground or embedded in concrete slab on ground.

C. Concealed: Inside building, above grade and located within walls, furred spaces, crawl spaces, attics, above suspended ceilings, etc. In general any item not visible or directly accessible.

D. Connect: Complete hookup of item with required services.

E. Contractor: Mechanical Contractor unless stated otherwise.

F. Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms. In general any
item that is directly accessible without removing panels, walls, ceilings or other parts of structure.

G. Furnish: Purchase and deliver to job site in new condition.

H. Install: Place, secure and connect as required to make fully operational.

I. Provide: Furnish and install as defined above; perform work.

J. Rough-in: Provide all indicated services in the necessary arrangement for making final connections to fixture or equipment.

K. Indoor: Enclosed within building structure, crawl spaces, etc.

L. Use (verb): Furnish and install as defined above.

M. Outdoor: Outside of building structure.

1.4 ABBREVIATIONS AND SYMBOLS

A. Abbreviations contained in various sections of the specifications and drawings refer to the following organizations, societies, associations standards, publications, terms, etc.:

1. AABC: Associated Air Balance Council
2. AMCA: Air Moving and Conditioning Association, Inc.
3. ANSI: American National Standards Institute, Inc.
4. ARI: Air-conditioning and Refrigeration Institute
5. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers
6. ASME: American Society of Mechanical Engineers
7. ASTM: American Society for Testing and Materials
8. AWS: American Welding Society
9. AWWA: American Water Works Association
10. NEBB: National Environmental Balancing Bureau
11. NEMA: National Electric Manufacturers Association
12. NFPA: National Fire Protection Association
13. OSHA: Occupational Safety and Health Act
14. SMACNA: Sheet Metal and Air Conditioning Contractors’ National Association
15. UL: Underwriters’ Laboratories

B. Other abbreviations and symbols are scheduled on the drawings.

1.5 REGULATIONS AND STANDARDS

A. It is the Contractor’s responsibility to install all work to meet or exceed minimum requirements stipulated in current issues of applicable standards, codes, or
regulations. Where drawings or specifications prescribe requirements exceeding those minimums, the work shall be installed in accordance with the drawing or specification requirements. Particular attention is directed to the following. This list does not include all standards, codes, and regulations which may be applicable; other Federal, State, and local regulations may apply.

1. Occupational Safety and Health Administration (OSHA).
2. State Fire Marshal and Local Fire Marshal.
3. Local Building, Mechanical, Plumbing, & Fire Codes, all volumes.
5. Factory Mutual Insurers.
7. International Association of Plumbing and Mechanical Officials (IAPMO)
9. Division of State Architects (DSA).
10. Any other applicable Federal, State and local laws and regulations.
11. Do not construct anything in these drawings and specifications to permit work not conforming to these requirements. The regulations shall govern where they require higher standards or are violated by the drawings and specifications. Consider rulings and interpretations of the enforcing agencies as part of these specifications. Comply with the drawings and specifications showing work exceeding minimum code requirements.

B. All regulations and standards shall be the latest issued unless the governing authority requires the use of an earlier issue. Provide all work required by the governing authority, even if it is not indicated on drawings or in the specifications, at no additional cost or time to the project.

1.6 DRAWINGS AND SPECIFICATIONS

A. Consider all drawings and all divisions of these specifications as a whole and provide work of this section as shown anywhere therein. Absolute accuracy of the drawings and specifications cannot be guaranteed. While every effort has been made to coordinate the locations of equipment covered under other sections or divisions of these specifications, it is the responsibility of the Contractor to coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before submitting bid or fabricating work.

B. Report discrepancies in time to avoid unnecessary work, and make changes as directed by the Engineer. Do not make any changes or additions that are subject to additional compensation without written authorization, based upon an agreed price. Any changes made without the above mentioned authorization shall be at Contractor's own risk and expense. Follow manufacturers' directions where they cover points not specifically indicated; however, if they are in conflict with these
drawings and specifications, obtain clarifications from the Engineer before starting work.

1.7 ALTERATION PROJECT PROCEDURES

A. Materials: As specified in product Sections; match existing products and work for patching and extending work.

B. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.

C. Remove, cut, and patch work in a manner to minimize damage and to provide a means of restoring products and finishes to original and/or specified condition.

D. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent finishes.

E. Where new work abuts or aligns with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.

F. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect/Engineer.

G. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections.

H. Finish surfaces as specified in individual product Sections.

1.8 CUTTING AND PATCHING

A. Refer to Division 1 section “Cutting and Patching”.

1.9 START-UP AND COMMISSIONING SERVICES

A. Contractor shall be responsible for proper operation of all systems, minor subsystems, and services provided under this section. He shall coordinate startup and commissioning procedures, meetings, calibration, and system checkout with all subcontractors and trades involved. Any system operational problems shall be diagnosed and all correctional procedures shall be initiated with the various subcontractors as required to bring the system into compliance with the design intent.

B. The contractor shall be responsible for preparing a written commissioning and startup procedure including check off list and report format showing design conditions and blanks for indicating actual operating conditions. The report format shall include each piece of equipment and all items that require adjustment.

C. Personnel performing commissioning and startup services shall be fully qualified, experienced, and normally engaged in this type of work. If the contractor does not have such personnel available from their own company, they shall hire, at their own expense, subcontractors who are qualified personnel.
D. Construction Manager shall regularly communicate with commissioning team through memos and progress reports to apprise them of progress and scheduling changes.

E. Commissioning and startup meetings: Construction manager shall schedule and conduct the meetings with team members in attendance as needed. These will include general, mechanical, controls, electrical contractors and subcontractors as appropriate.

F. Functional performance testing will not begin until startup, pre-functional testing and balancing are completed for given system.

G. The contractor shall designate one field person who has the overall responsibility for startup procedures which includes testing and balancing. He shall directly supervise that startup and commissioning operations and be available for required coordination before, during, and after.

H. Prior to startup, ensure that the systems are ready, including but not limited to the following: Proper equipment rotation; the systems are flushed and are clean; proper wiring; auxiliary connections; lubrication, venting; controls; all filters and strainers installed; and properly set relief and safety valves.

I. All electrical testing must be complete and test results submitted before equipment startup to avoid power interruptions during mechanical equipment startup and testing.

J. Equipment or systems shall not be started until systems are completed and/or when other continuing work could possibly damage completed systems if they are in operation.

K. Start and operate all systems. Provide the services of factory trained technicians for startup of major equipment and systems including, but not limited to, chillers, air conditioning units variable frequency drives (VFD), temperature controls, pumps, boilers, etc.

L. The contractor shall provide all labor, materials and services necessary for the commissioning, startup and operation of all systems and equipment furnished and installed under this section. Contractor and commissioning team shall make every effort to expedite testing process and minimize unnecessary delays without compromising integrity of procedures.

M. The contractor and factory representative shall check all equipment during the initial startup to ensure correct rotation, proper lubrication, adequate fluids or air flows, non-overloading electrical characteristics, proper alignment, and vibration isolation. Systems shall be checked for air and/or water flows throughout without blockages. Air conditioning units and systems shall be checked for proper damper connections and positions, aligned and adjusted belt drives, proper lubrication, air filters installed, non-excessive electrical characteristics, and minimal vibration. Other miscellaneous equipment shall be started and operated as described above as applicable.

N. During initial operation of the system and unit substantial completion, qualified personnel shall be provided and designated for maintaining the equipment and systems in good running order. Failure of equipment during this period due to lack of
proper supervision is the responsibility of the contractor and continued failures shall be grounds for the Owner to provide such services with back charges to the contractor.

O. Check all motor starters and verify that the heater sizing is correct, taking length of electrical feeders into consideration. Record amp readings on all motors.

P. Make sure all control systems are calibrated and functioning properly. Prepare a log to indicate the check, calibration, set point, etc. of each control device.

Q. Functional performance tests verify that components, equipment, systems, and interfaces between systems operate correctly. They include operating modes, interlocks, control sequences, and responses to emergency conditions.

R. Functional performance testing and verification may be achieved by direct manipulation of system inputs (i.e. heating or cooling sensors), manipulation of system inputs by building automation system (i.e. software override of sensor inputs), trend logs of system inputs and outputs using building automation system, or short term monitoring of system inputs and outputs using stand-alone data loggers.

S. If retesting is necessary because any equipment or system reported to have been successfully started up or pre-functionally tested is found during functional testing to be faulty, the additional cost of retest shall be the responsibility of the contractor.

T. Commissioning and Verification of control system:
   1. The control systems shall be completely commissioned to ensure all aspects of the system are operating as intended and at optimum tuning.
   2. All wiring connections shall be verified and traced from field device to panel to ensure proper connections.
   3. All measured values shall be verified by a hand held calibrated device to validate that value indicated by the control system is in fact the actual measured value.
   4. All loops shall be properly tuned to obtain the desired control value. Each loop shall be “upset” and put back in control to demonstrate its ability to stabilize quickly.
   5. A final point-by-point report shall be submitted that indicates the date of each verification, the results, and shall be initialed on each page by the person performing the reading.

U. A final and complete commissioning, startup report shall be submitted prior to final acceptance and payment. This report shall be signed by each person doing the commissioning/startup task and by the responsible field person. Report shall include, but not be limited to, date of test; instrument used; date of last calibration; temperatures; set points; rpm; voltage; amperage; pressures; stability; etc.

1.10 DEMONSTRATION AND INSTRUCTIONS

A. Provide operation and maintenance of Products to Owner's personnel two (2) weeks prior to date of Training.
B. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at designated location.

D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

E. The amount of time required for training on each item of equipment and system is that specified in individual sections, or as noted below:

Chiller Equipment and piping Systems Two sessions at 8 hours each

Temperature Control System Two sessions at 8 hours each

1.11 TESTING, ADJUSTING, AND BALANCING

A. Mechanical Contractor will appoint and employ services of an independent firm to perform testing, adjusting and balancing.

B. The independent firm hired by the Mechanical Contractor will perform services specified in Section 23 05 93, “Testing, Adjusting and Balancing”.

C. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with the requirements of the Contract Documents.

1.12 CLOSEOUT PROCEDURES

A. Refer to Division 1 section “Closeout Procedures”.

B. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect/Engineer’s inspection.

C. Provide submittals to Engineer that are required by governing or other authorities.

1.13 FINAL CLEANING

A. Refer to Division 1 section “Closeout Procedures”.

B. Execute final cleaning prior to final inspection.

C. Clean interior and exterior of all equipment; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum and clean all dust from air distribution system including ductwork and grilles.

D. Clean equipment and fixtures to a sanitary condition.

E. Replace filters of operating equipment.
F. Clean debris from gutters and drainage systems.

G. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.14 PROJECT RECORD DOCUMENTS

A. Refer to Division 1 section “Project record Documents”.

B. Maintain on site, one set of the following record documents; record actual revisions to the Work:
   2. Specifications.
   3. Addenda.
   4. Change Orders and other Modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.

C. Store Record Documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and Modifications.

F. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish main floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract Drawings.

G. Delete Engineer title block and seal from all documents.

H. Submit documents to Engineer.

1.15 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 section “Operation and Maintenance Data”.

1.16 WARRANTIES

A. Refer to Division 1 section “Operation and Maintenance Data”.
B. Provide duplicate notarized copies.

C. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.

D. Provide Table of Contents and assemble in three (3) D side ring binders with durable plastic cover.

E. Submit prior to final Application for Payment.

F. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.17 BUILDING CONTROL BOOKS

A. Refer to Division 1 section “Operation and Maintenance Data”.

B. At the time Operation and Maintenance Data are submitted as specified, submit 3 loose, but bundled, sets of Building Control Information on 3 hole punched 8-1/2”X11” paper. The Building Control Information shall be organized as follows:
   1. Table of contents with appropriate division tabs.
   2. Contractors (Name, Address, Telephone and Contact).
   3. Sub-Contractors (Name, Address, Telephone and Contact).
   4. Material Suppliers (Name, Address, Telephone and Contact).
   5. Warranties (Cards and Information Including Start Date, Duration, Company Name, Address, Telephone and Contact).

1.18 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.

B. Deliver to Project site and place in location as directed; obtain receipt prior to final payment.

1.19 SITE VISIT

A. Visit the site before submitting a bid. No extra payment will be made for additional work that would have been made apparent by the site visit.

1.20 OBSERVATION BY Engineer

A. Work may be observed at any time by the Engineer or his representative. Work covered or concealed before being observed and accepted shall be opened and uncovered upon request, and replaced at no additional cost or time to the project.
1.21 INTERRUPTION OF EXISTING SERVICES AND UTILITIES

A. Coordinate with other Sections and schedule sequence of accomplishing the work covered by this division in such a manner as not to interrupt existing services and utilities at a time that will inconvenience the Owner.

1.22 FEES

A. Secure and pay fees for permits, licenses, inspections and royalties required for work of this Section.

1.23 OWNER-FURNISHED PRODUCTS

A. Products furnished to site and paid for by Owner.

B. Owner's Responsibilities:
   1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
   2. Arrange and pay for product delivery to site.
   3. On delivery, inspect products jointly with Contractor.
   4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
   5. Arrange for manufacturers' warranties, inspections and service.

C. Contractor's Responsibilities:
   1. Review Owner reviewed shop drawings, product data, and samples.
   2. Receive and unload products at site; inspect for completeness or damage, jointly with Owner.
   3. Handle, store, install and finish products.
   4. Repair or replace items damaged after receipt.

1.24 SUBMITTAL PROCEDURES

A. Refer to Division 1 section “Submital Procedures”.

B. General:
   1. In addition to the procedures indicated below follow the procedures specified in Division 1 where they exceed the requirements of this section.
   2. Provide submittals of material or equipment in accordance with each specification section.
   3. Each item submitted shall be labeled or identified the same as on the drawings. (CH-1, CHWP-1 CHWP-2, etc.)

C. Equipment, materials, and products specifically identified, described, and scheduled on the drawings are the basis of design. The other manufacturers or suppliers which may be named in the specification only indicate the general acceptability of the manufacturer or supplier and are considered alternates. It is the Contractor's responsibility to research, select, and prove, through the submittal process, that the
specific model, size, or type of the alternate proposed manufacturer is equal and will perform equal to that which is the basis of the design. Operational characteristics for such items as outlet velocities, power input, sound levels, efficiencies, etc., shall be considered in addition to the overall performance, output, and physical constraints.

D. The Contractor assumes full responsibility that alternative items substituted for the scheduled manufacturer will meet the job requirements and is responsible for the cost of redesign and modifications necessary due to this substitution, for all trades. Revisions or additional work required by any trade due to the use of substitute materials and equipment shall be fully indicated on detailed drawings submitted with the shop drawings and all additional costs shall be accounted for in the final proposed substitution.

E. Mark submittal "Exactly as Specified" or accompanied by a letter from the supplier explaining in detail what differences, if any, exist between the submitted item and the scheduled item. Failure to point out the differences will be considered cause for disapproval. If differences are not indicated and/or not discovered during the submittal review process, the Contractor will still remain responsible for providing equipment and materials that meet the specifications.

F. Acceptable Manufacturers: Subject to compliance with the requirements of the individual specification sections, provide materials and equipment from the indicated manufacturers only. Submittals of material or equipment manufactured by other than those indicated may be returned, not reviewed. If no manufacturers are indicated, then any product or material which complies with the specification and for the intended application may be submitted.

G. The mechanical and electrical components, structural systems, service clearances, and controls for all equipment are selected and sized, based on the basis of design manufacturer and equipment scheduled. If substitutions and/or equivalent alternate equipment are furnished, it shall be the responsibility of all parties concerned, involved in, and furnishing the substitute and/or equivalent alternate equipment to verify and compare the characteristics (capacity, size, clearance, acoustics, etc.) and requirements of that submitted to that scheduled. If greater capacity or more materials or labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then it shall be the responsibility of the parties involved in providing the substitute and/or equivalent items of equipment to provide all compensation for additional charges made for the proper rough-in, circuitry, support, and connections for the equipment furnished for all trades affected. No additional charges shall be allowed for such revisions.

H. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals.

I. The Engineer will review submitted shop drawings and documents for general conformance with the design concept of the project and the information contained in the contract documents. The Engineer's review is for the convenience of the Owner in following the work and does not relieve the Contractor of the responsibility of deviations from the requirements stated in this specification and contract documents.
J. The Engineer's review shall not be construed as a complete or detailed check of the work submitted, nor shall it relieve the Manufacturer or Contractor of responsibility for errors or omissions of any sort in the shop drawings and samples, or from the necessity of furnishing any work required by the contract documents. The review of a separate item shall not indicate review of the complete assembly in which it functions. Nothing in the Engineer's review of the shop drawings and samples shall be considered as authorizing 1) a departure from contract documents and specifications, or 2) additional cost to the owner, or 3) increased time for completion of the work.

K. Submittals are not reviewed for quantities, dimensions, weights, fabrication processes, construction methods, coordination with work of other trades, construction safety practices, service clearance, coil and motor location, location of control and electrical panels, and other layout constraints. These items shall remain the sole responsibility of the contractor.

L. The Engineer will review submittals with reasonable promptness and will return them to the Vendor/Supplier/Manufacturer stamped to indicate the appropriate action taken as follows:
   1. No Exceptions Taken.
   2. Exceptions Taken As Noted. No resubmittal required.
   3. Exceptions As Noted. Resubmit.

M. Markings or comments or the lack thereof shall not be construed as relieving the Vendor/Supplier/Manufacturer/Contractor from complete compliance with the project drawings and specifications.

N. No part of the work shall be started in the shop or in the field until the Engineer have reviewed the shop drawings and samples for that respective portion of the work. Shop drawings and samples shall be submitted for review sufficiently in advance of the scheduled start of the work in the shop or in the field to allow ample time, in consideration of the number and complexity of the drawings in the submittal, for the Engineer to make an orderly review. No extension of time to complete the work will be granted to the Vendor/Supplier/Manufacturer by reason of failure to perform in this respect.

O. Each shop drawing and sample submitted for review shall be accompanied by a letter of transmittal, and shall be identified by the project title, Vendor's/Supplier's/Manufacturer's name, and a reference to the related part of the contract documents.

P. Welding certificates.

1.25 ESTABLISHED STANDARD MANUFACTURER/OTHER ACCEPTABLE MANUFACTURERS

A. Refer to Division 1 section “Project Requirements and Substitutions”.
1.26 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

C. Provide interchangeable components of the same manufacturer, for similar components.

1.27 TRANSPORTATION AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.28 STORAGE AND PROTECTION

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

B. For exterior storage of fabricated products, place on sloped supports, above ground.

C. Provide off-site storage and protection when site does not permit on-site storage or protection.

D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surfaces in a well-drained area. Provide mixing with foreign matter.

F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

G. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

1.29 SHOP DRAWINGS

A. Refer to “Submittal Procedures” above and Division-1 for additional requirements.

B. Submit information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard
information prepared without specific reference to the Project is not considered Shop Drawings.

C. Shop Drawings include fabrication and installation drawings and directions, setting diagrams, schedules, patterns, templates and similar drawings, and installation for metal and wood supports and anchorages. Include as a minimum the following information on drawings or diagrams:
   1. Dimensions
   2. Identification of products and materials included
   3. Compliance with specified standards
   4. Notation of coordination requirements
   5. Allowance for expansion, contraction, and deflection/movement of support structures.

D. Notation of dimensions established by field measurement

E. Clearances for access and service

F. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

G. Upon contractor’s request, engineer can make electronic data files available at contractor’s expense in order to enable contractor to expedite the production of working/coordination/shop drawings for the project. Transfer of the electronic data files to Contractor is for informational purposes only and will only be completed after a waiver is signed by contractor and owner relieving engineer of all liability resulting from use of electronic files and all engineer costs to produce electronic files in a format suitable for distribution are paid by contractor.

1.30 MATERIAL AND EQUIPMENT

A. Place materials and equipment on order in time to avoid job delay or hindrance. Schedule deliveries to coincide, as nearly as possible, with the construction schedule.

B. Use only new, unused materials and equipment unless specifically noted otherwise.

C. All materials and equipment not conforming to the requirements of these specifications will be considered as defective. Items which have been accepted or approved at one time and place, but which subsequently fail to conform to the requirements of these specifications will also be considered as defective. All such defective materials, whether in place or not, will be rejected. Remove such materials and equipment immediately from the site of the work.

D. Prior to ordering materials or starting work, verify all measurements at the site. No extra compensation will be allowed for differences between actual dimensions and the measurements shown on the drawings.

E. Except as specifically noted otherwise, follow the installation and/or maintenance directions provided by the manufacturer for all materials and equipment.
F. For each part of the work furnish all materials and equipment of the same type by the same manufacturer.

1.31 PROTECTION OF BUILDING

A. Protect new and existing building structures and adjacent finished surfaces during construction. Patch, repair, and refinish existing work damaged by work under this Division to match adjacent undisturbed areas. Patching, repair, and refinishing is to be performed by workmen skilled in the Sections involved.

1.32 RECORD DRAWINGS

A. Refer to Division 1 section “Project Record Documentation”.

B. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate the following installed conditions:
   1. Indicate actual inverts and horizontal locations of underground piping and conduits.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Accepted substitutions, contract modifications, and actual equipment and materials installed. This includes updating all equipment schedules with actual equipment provided.
   4. Indicate duct and pipe routing and locations.
   5. Refer to division-1 for additional requirements.

C. Contractor shall maintain a complete set of documents on site that are marked-up during the construction process indicating all changes that have been made. These mark-ups shall be maintained on a regular basis so they are current as the construction is in process and available for inspection by the Engineer. Markups shall include changes to pipe routing and sizing.

D. Upon completion of the construction, the contractor shall transfer all mark-ups into AutoCAD and update the contract documents into record documents and the shop/coordination drawings into as-built documents.
   1. Upon contractor’s request, engineer can make electronic data files available at contractor’s expense in order to enable contractor to expedite the production of record drawings for the project. Transfer of the electronic data files to Contractor is for informational purposes only and will only be completed after a waiver is signed by contractor and owner relieving engineer of all liability resulting from use of electronic files and all engineer costs to produce electronic files in a format suitable for distribution are paid by contractor.
   2. Engineer makes no representations as to the accuracy or completeness of electronic data files. They are provided to the contractor as a start point to upgrade to Record Drawings.
   3. The contractor record documents shall be in the same CAD program, version, and operating system as the original Contract Drawings.
   4. Delete architect/engineer title block and seal from all documents.
E. Record and as-built document updates shall include schedules where contractor has supplied alternate manufacturers to those scheduled or where submitted performance varies.

F. Contractor shall prepare an electronic CAD file of record and as-built drawings and the drawings shall be updated with the mark-up, RFI and change orders.

G. Provide a minimum of one copy of the markup documents, a hard copy set of prints of the record and as built documents, and one electronic copy (disk) of the CAD files.

1.33 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply fully with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, contractor shall request clarification from Architect/Engineer before proceeding.

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform work by persons qualified to produce workmanship of specified quality.

F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.34 FIELD SAMPLES

A. Install field samples at the site as required by individual specifications Sections for review.

B. Acceptable samples represent a quality level for the Work.

C. Where field sample is specified in individual Sections to be removed, clear area after field sample has been accepted by Architect/Engineer.

1.35 MOCK-UPS

A. Tests will be performed under provisions identified in this section.

B. Assemble and erect specified items, with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Where mock-up is specified in individual Sections to be removed, clear area after mock-up has been accepted by Engineer.

1.36 INSPECTION AND TESTING LABORATORY SERVICES

A. Refer to Division 1 section “Quality Requirements”.

Chiller Replacement
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Contra costa community college
1.37 MANUFACTURERS’ FIELD SERVICES AND REPORTS

A. Submit qualifications of observer to Engineer thirty (30) days in advance of required observations. Observer subject to approval of Engineer and/or Owner.

B. When specified in individual specification Sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment and to initiate instructions when necessary.

C. Manufacturer's Field representative shall report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

D. Submit report in duplicate within five (5) days of observation to Engineer for review.

1.38 SPECIFIC MANUFACTURER AND MODEL

A. Trade names are used to establish standards. Where more than one name is given, the first listed is the basis of the project design and will be described fully. Other names indicate product lines of generally comparable quality but are subject to the Architect's/Engineer's direction.

B. Where specifications call for an installation to be made in accordance with manufacturers recommendations, a copy of such recommendations shall at all times be kept in the job superintendent’s office, and shall be available to the Owner’s representative.

C. Follow manufacturer's instructions where they cover points not specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Engineer before starting work.

1.39 NO SPECIFIC MANUFACTURER

A. Where no specific make of material or equipment is mentioned, an appropriate product of approved manufacturer may be used, provided it conforms to the requirements of system.

1.40 U.L. LABEL

A. Furnish UL labeled and listed materials and equipment except when equipment is of a type for which labeling or listing services are not available from UL.

1.41 CURRENT MODELS

A. Materials and equipment shall be new, current models by each manufacturer and shall bear complete identification by the manufacturer. Materials and equipment shall be guaranteed by the manufacturer to equal or exceed specified, submitted and published specifications, such as pressure ratings, capacities, etc.
1.42 SERVICE CAPABILITY

A. Provide materials and equipment of major and reputable manufacturers with ability to render competent and thorough technical services through local organizations, and to expeditiously furnish spare parts.

1.43 FINISHES AND PAINTING

A. Provide all equipment with a factory painted finish. All other painting will be done per the Architect's direction.

B. Touchup scratches in factory finished surfaces to match original. Obtain touch-up paint from the manufacturer of the piece of equipment.

1.44 COORDINATION

A. Coordinate with work performed by other sections/divisions in order to accommodate the requirements of this section and to ensure adequate space and proper location for all necessary work on this project whether or not work is under this section. Provide coordination drawings, as indicated. Coordination shall be done prior to order or manufacture of any systems or components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

E. Coordinate work with the Electrical Division. Furnish the Electrical Division with shop drawing information for indicating ratings and control circuits required for the actual equipment furnished. Coordinate voltage, phase, and load requirements, prior to ordering equipment, to insure mechanical and electrical matches. All equipment shall be provided and ordered to suit the power available.

F. Layout support pads, curbs, sleepers, anchor bolts, etc., for all mechanical equipment and materials so as to be in the proper location for the equipment actually ordered. These pads shall be of adequate dimension to provide for proper mounting of equipment isolators and equipment mounting so that anchor bolts meet all seismic criteria. Contractor shall allow for proper service clearances.

G. Provide templates, information, and instructions to other divisions as necessary to properly locate holes and openings to be cut or provided for mechanical work.

H. Layout piping, and other mechanical systems and confirm all sizes of systems and components to be sure they fit the space available prior to ordering and manufacturing of components. Be certain to allow for proper pipe slopes.

I. Provide proper clearances for access to and service of all equipment and items requiring adjustment including shutoff valves.
J. Coordinate all disciplines to insure maximum point loads that can be attached to structural members are not exceeded. See other sections and structural contract documents for requirements. Provide intermediate supports between existing structural members (Unistrut, angle, etc.) as necessary to not exceed maximum point loads.

K. Lay out trench locations, do all excavation, shoring, laying, backfilling, and compacting for work performed under this division and not provided under other divisions. See other divisions for specification requirements.

1.45 COORDINATION DRAWINGS

A. Prepare and submit, for review, large scale (minimum 1/4" = 1'-0") coordination drawings showing location and elevations of all equipment, ducts, piping, cable trays, conduits, structural, and other items in the area. These shall be fully coordinated with all other trades and Owner supplied items. Check routing and elevations of all piping, ductwork, conduit and equipment before fabricating. Report any conflicts that cannot be solved in the field to the Architect/Engineer. Extra charges shall not be allowed due to lack of coordination prior to, or during, construction. These drawings shall be distributed to, and coordinated with, all other trades that are affected.

1. In addition to plan view, indicate heights to clarify clearances from structure and from other trades. Use partial sections where necessary.

2. Provide proper clearances for access to and service of all equipment and items requiring adjustment including shutoff valves.

3. Coordinate the location of access panels to insure all equipment and devices have proper access for servicing and adjusting.

4. The coordination drawings shall be reviewed and checked for completeness by the general contractor. Review by the architect and engineer is to assist the contractor and to attempt to point out obvious errors. Responsibility for proper coordination shall remain with the contractor.

B. Differences or disputes concerning coordination, interference, or extent of work between sections shall be decided by general contractor.

C. Extra charges shall not be allowed due to lack of coordination (or lack of coordination drawings) prior to or during construction.

D. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work. Indicate the proposed locations of ductwork, piping, conduit, equipment, and materials. Include the following:

1. Clearances for installing and maintaining insulation, including clearances for servicing and maintaining equipment, and space for equipment disassembly required for periodic maintenance.

2. Clearances for electrical and control components and panels.

3. Equipment connections and support details.

4. Exterior wall and foundation penetrations.

5. Interior floor penetrations
6. Fire-rated wall and floor penetrations.
7. Sizes and location of required concrete pads and bases.
8. Support, bracing and anchor locations for equipment and conduit.

E. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

F. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

G. Prepare reflected ceiling plans to coordinate and integrate installations, access panel and door locations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items where ceilings are to be installed.

1.46 STRUCTURAL MODIFICATION
A. Do not cut structural members except with written approval of the Engineer.

1.47 WORKMANSHIP
A. Workmanship shall be first class throughout, performed only by competent and experienced workmen in a manner satisfactory to the Engineer. Replace work falling below these standards as directed by the Engineer. Constant supervision of the work either by the Contractor or his competent representative shall be maintained. Welding shall be done by certified pipe welders.

1.48 QUIETNESS
A. Quietness during construction is a requirement. Eliminate noise, other than that caused by specific equipment operating at optimum conditions as directed by the Architect.

1.49 GENERAL ELECTRICAL
A. All equipment shall be selected to suit power available; this requirement supersedes other portions of the specifications.

B. All equipment shall conform to the National Electrical Manufacturer's Association Standards, and shall bear the Underwriter Laboratories label unless such listing is not available.

C. Load and line voltage connections to equipment will be made by the Electrical Division unless specifically noted otherwise. Coordinate work with the Electrical Division. Furnish the Electrical Division with shop drawing information for indicating ratings and control circuits required for the actual equipment furnished.

D. Guard opening giving access to "live" or rotating parts to prevent accidental contact with such parts.
1.50 MANUFACTURER’S INSTRUCTIONS

A. When specified in individual specification Sections, submit manufacturers’ printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

B. Identify conflicts between manufacturers’ instructions and Contract Documents.

C. Follow Manufacturer’s installation details except as specifically modified on the drawings, and provide any valves or special fittings or other specialty items called for by them as required in order to make the equipment perform as intended.

1.51 MANUFACTURER’S CERTIFICATES

A. When specified in individual specification Sections, submit manufacturers’ certificate to Architect/Engineer for review, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect/Engineer.

1.52 SEISMIC RESTRAINTS

A. General: All equipment, piping and materials shall be fastened to the structure with properly sized and structurally engineered anchors, bolts, and restraints to prevent permanent displacement in any direction caused by lateral motion, overturning, or uplift.

1. PIPING, AND DUCTWORK SYSTEMS SHALL BE BRACED TO RESIST THE FORCES PRESCRIBED IN ASCE 7-05 SECTION 13.3 AS DEFINED IN ASCE 7-05 SECTION 13.6.8, 13.6.7, 13.6.5.5 ITEM 6, AND CBC 1614A.1.13.

B. Calculations:
   1. Submit drawings, calculations, and specifications that clearly indicate the furnished systems for support of equipment, piping, ductwork and materials.
   2. Calculations shall be in a form that can be readily reviewed by the Owner, and shall be prepared, stamped and signed by a licensed Structural Engineer.
   3. Calculations for all seismic restraints including standard NFPA approved restraints shall indicate how the restraints are adequately supported by the secured to the building structure.

C. Provide specifications of anchor bolt size and loads with installation instructions for each item.

D. All structural steel shall be ASTM A36 (Fy = 36,000 psi). All pipe steel shall be ASTM A501 (Fy = 36,000) or ASTM A53, type E or S, grade B (Fy = 35,000). All tubular steel shall be ASTM A500 grade B (Fy = 46,000 psi). All bolts shall be ASTM
A307 or ASTM A325. Other ASTM specified materials to be used in the unit and support shall be submitted for approval. Latest American Institute of Steel Construction (AISC) and American Welding Society (AWS) codes shall apply.

E. All bolts, anchor bolts, expansion bolts, etc., shall be installed with steel washers. All high strength bolting shall be inspected by an independent testing laboratory. All welding shall be by welders holding valid certificates and have current experience in type of welds performed. Certificates shall be those issued by an accepted testing agency.

F. All welding shall be done by E70 series low hydrogen rods. All welding shall be per American Welding Society standards. Vendor may shop weld only the portions of unit and support which is factory preassembled. All field connections shall be bolted. Shop welds shall be shown on shop drawings. All full penetration welds shall be tested and certified by an independent testing laboratory.

G. Expansion Anchors in Hardened Concrete:
   1. An expansion anchor is defined as a mechanical fastener designed to expand in a self-drilled or predrilled hole of a specified size, and to engage the sides of the hole in one or more locations to develop shear and/or withdrawal resistance to applied loads without the use of grout, epoxy, or dry pack.
   3. Where the anchors are subjected to combined shear and pull-out forces, the ratio of the actual shear to the allowable shear, plus the ratio of the actual pull-out to the allowable pull-out, shall not exceed 1.00 for gravity loads or seismic forces.
   4. Expansion anchors shall be specified in calculations and drawings by Manufacturer's name and model number, as well as by nominal thread size and required embedment. They shall be sized and installed in accordance with the above referenced conditions and requirements, as well as Manufacturer's recommendations, and ICC Evaluation Report recommendations for the specific anchor.

H. All isolators shall be fastened to the structure and to the equipment with properly sized and structurally engineered anchors and bolts as specified above. The isolator Manufacturers shall submit seismic calculations confirming that such bolts and anchors can handle the specified seismic requirements.

I. The equipment Manufacturer shall furnish the weight of the equipment at each point of support.

J. The SMACNA "Guidelines for Seismic Restraints of mechanical Systems and Plumbing Piping Systems" may be used for reference.

K. Seismic Bracing for Hangers and Duct: All required seismic bracing shall be installed as per the State of California Code of Regulations, Title 24, Division T-22 modified to meet an importance factor (I) of 1.0.
L. Under California Code of Regulations Title 24, Division T-22, seismic restraints may be omitted from the following installation:
   1. Gas piping less than 1" inside diameter.
   2. Piping in boiler and mechanical equipment rooms less than 1 1/4" inside diameter.
   3. All other piping less than 2 1/2" inside diameter.
   4. All piping suspended by individual hangers 12" or less in length from the top of pipe to the bottom of the support for the hanger.
   5. All rectangular air handling ducts less than 6 square feet in cross sectional area.
   6. All round air handling ducts less than 28" in diameter.
   7. All ducts suspended by hangers 12" or less in length from the top of the duct to the bottom of the support or the hanger connection point.

M. The Title 24 Division T-22 allowable omissions do not supersede any requirements indicated in NFPA or required by the Fire Marshal or building official. Contractor shall comply to the most stringent of these requirements.

N. Provide for attachment to portions of the building structure capable of bearing the loads imposed. Design systems to not overstress the building structure.

O. The Construction Manager shall coordinate the load requirements from all contractors so that no combination of loads exceeds the structural limitations.

P. Design and install all support systems to comply with the seismic zone 4 requirements of the California Building Code (CBC). Use an importance factor (I) of 1.0.

Q. The Engineer (under Contract of the Mechanical Contractor) providing the required calculations shall inspect all supports and attachments designed by him and provide a letter certifying that they have been installed as designed.

PART 2 - PRODUCTS (See Subsequent Sections)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation and Arrangement: Install all mechanical work to permit removal (without damage to other parts) of coils, fan shafts and wheels, filters, belt guards, sheaves and drives, and all other parts requiring periodic replacement or maintenance. Arrange pipes, raceways and equipment to permit ready access to valves, cocks, traps, starters, motors, and control components. Doors and access panels shall be kept clear.

B. Access: Provide access panels in equipment, as required for inspection and for proper maintenance.
C. Location of pipes, equipment, fixtures, etc., shall be adjusted to accommodate the work and to avoid interferences anticipated or encountered. Determine the exact route and location of each pipe and duct prior to fabrication.

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example, steam, condensate and plumbing drains shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.

2. Offsets, transitions and changes in directions in pipes and ducts shall be made to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Furnish and install all traps, air vents, sanitary vents, etc., required to affect these offsets, transitions and changes in direction.

D. Location of valves, traps, strainers, motors, damper operators, etc., shall be such as to be easily accessible by a person standing on the floor. If any such items are not in the open they shall be accessible through access openings in the building construction. Valves in vertical risers shall be located not over 5 feet above the floor. If circumstances at a particular location make this accessibility difficult or inconvenient, the situation shall be discussed with the Architect before installing apparatus at reduced accessibility locations.

E. Manufacturers' Installation Details: Conform to manufacturer's instructions. Provide any valves or fittings recommended by manufacturers.

F. Openings in Pipes: Keep closed during construction.

G. Ferrous metal work exposed to the weather, other than cast iron, shall be hot dip galvanized.

H. Nameplates: Provide for each fan and pump per the equipment schedules and its associated motor controller (if not in a motor control center); including any special instructions for fan or pump use; laminated black and white plastic with lettering cut through to white background. Submit list to the Architect for prior approval.

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SECTION 23 05 00
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   7. Grout.
   8. Mechanical demolition.
   9. Equipment installation requirements common to equipment sections.
   10. Painting and finishing.
   11. Concrete bases.
   12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
F. The following are industry abbreviations for plastic materials:
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at no additional cost to the Owner. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate and provide the access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Coordinate with construction manager for Access panels, doors and requirements from other trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 and Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      b. Dresser Industries, Inc.; DMD Div.
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d. JCM Industries.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer’s Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer’s SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
   a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO INC.
      b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      b. Fernco, Inc.
      d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
E.  Dielectric-Flange Kits:  Companion-flange assembly for field assembly.  Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1.  Manufacturers:
      a.  Advance Products & Systems, Inc.
      b.  Calpico, Inc.
      c.  Central Plastics Company.
      d.  Pipeline Seal and Insulator, Inc.
   2.  Separate companion flanges and steel bolts and nuts shall have 150-psig minimum working pressure where required to suit system pressures.

F.  Dielectric Couplings:  Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1.  Manufacturers:
      a.  Calpico, Inc.
      b.  Lochinvar Corp.

G.  Dielectric Nipples:  Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1.  Manufacturers:
      a.  Perfection Corp.
      b.  Precision Plumbing Products, Inc.
      c.  Sioux Chief Manufacturing Co., Inc.
      d.  Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

   A.  Description:  Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1.  Manufacturers:
      a.  Advance Products & Systems, Inc.
      b.  Calpico, Inc.
      c.  Metraflex Co.
      d.  Pipeline Seal and Insulator, Inc.
   2.  Sealing Elements:  EPDM interlocking links shaped to fit surface of pipe.  Include type and number required for pipe material and size of pipe.
   3.  Pressure Plates:  Stainless steel.  Include two for each sealing element.
   4.  Connecting Bolts and Nuts:  Stainless steel of length required to secure pressure plates to sealing elements.  Include one for each sealing element.
2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.


G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.

B. Refer to Division 3 Section, “Cast in Place Concrete”.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 1 Section for "Cutting and Patching" and Division 2 Section for "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are accepted on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
   h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
   j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
   k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
   l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:
   a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.

h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.

i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.

j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable plain-end sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas minimum 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to minimum 2 inches above finished
floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

(1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
   7. PVC Nonpressure Piping Gasketed Joints: Join according to ASTM D 3139.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3212.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. Plain-End Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section, “Painting”.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer’s written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section “Metal Fabrications” for structural steel information and requirements.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Refer to Division 6 Section “Rough Carpentry” for wood supports and anchorages information and requirements.

B. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

C. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

D. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Refer to Division 3 Section "Cast-in-Place Concrete" for grouting information and requirements.

B. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

C. Clean surfaces that will come into contact with grout.

D. Provide forms as required for placement of grout.

E. Avoid air entrapment during placement of grout.

F. Place grout, completely filling equipment bases.

G. Place grout on concrete bases and provide smooth bearing surface for equipment.
H. Place grout around anchors.
I. Cure placed grout.

END OF SECTION 23 05 00
SECTION 23 05 29
HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. Related Sections include the following:
   1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
   2. Division 23 Section "Mechanical Vibration and Seismic Controls" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

C. Design seismic restraint hangers and supports for piping and equipment.

D. Design and obtain approval from authorities having jurisdiction for seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
C. Welding Certificates: Copies of certificates for welding procedures and operators.

D. All attachments to building structure shall be made in accordance with the Owners structural engineers requirements and weight limitations.

E. Submit shop drawings and calculations for review and approval by Owners structural engineer before installation.

1.6 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for equipment, duct and pipe support, trapeze, and seismic restraint by a qualified professional engineer, licensed in the State of California.

   1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Pipe Hangers:
      a. B-Line Systems, Inc.
      b. Carpenter & Patterson, Inc.
      c. Grinnell Corp.
      d. Michigan Hanger Co., Inc.
      e. National Pipe Hanger Corp.
      f. Piping Technology & Products, Inc.

   2. Channel Support Systems:
      a. B-Line Systems, Inc.
      b. Grinnell Corp.; Power-Strut Unit.
      c. GS Metals Corp.
      e. National Pipe Hanger Corp.
f. Unistrut Corp.

3. Thermal-Hanger Shield Inserts:
   a. Carpenter & Patterson, Inc.
   b. Michigan Hanger Co., Inc.
   c. Pipe Shields, Inc.
   d. Rilco Manufacturing Co., Inc.

4. Powder-Actuated Fastener Systems:
   a. Gunnebo Fastening Corp.
   b. Hilti, Inc.
   c. ITW Ramset/Red Head.
   d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to “Hanger and Support Applications” Article in Part 3 for where to use specific hanger and support types.
   1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
   2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
   1. Coatings: Manufacturer’s standard finish, unless bare metal surfaces are indicated.
   2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
   1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
   2. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
   4. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
   5. Material for Hot Piping: ASTM C 552, Type I cellular glass.
   7. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
8. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
9. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   3. Design Mix: 5000-psi, 28-day compressive strength.
   4. Refer to Division 3 Section “Cast-in-Place Concrete” for additional information and requirements”

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in Sections specifying equipment and systems.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
   1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape where allowed by seismic codes.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles where allowed by seismic codes.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge where allowed by structural codes.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams where allowed by structural codes.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.

G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
   1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
   6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
   7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

I. Space hangers for horizontal piping with the maximum distance between hangers as follows:
   1. copper 2" and smaller – 6'-0"
   2. steel 1¼" and smaller – 6'-0"
   3. copper 2½" and larger – 10'-0"
   4. steel 1½" and larger – 10'-0"
   5. cast iron soil – locate hangers within 18" of each joint at a maximum of 10'-0" for Bell & Spigot and 5'-0" for hubless.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
   1. Field assemble and install according to manufacturer’s written instructions.

C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

D. Install building attachments within concrete slabs or attach 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, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer’s operating manual.

F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

K. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.9.
   2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood inserts.
   6. Insert Material: Length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
B. Grouting: Place grout under supports for equipment as indicated on the drawings.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with 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 no roughness shows after finishing and 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 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting 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 paint 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 are specified in Division 9 Section "Painting."

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 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 CONDITIONS AND REQUIREMENTS

A. The Drawings and the General Provisions of the Contract including the General Conditions, Supplementary Conditions and Division 01 General Requirements apply to work of this section as fully as if repeated herein.

1.02 SCOPE OF WORK

A. Provide all labor, equipment and materials that are required to provide a complete installation as indicated on the drawings and in the specifications including that reasonably inferred for proper execution of this Division.

B. Coordinate with work performed under other divisions. Coordinate work done to accommodate requirements of this Division to ensure adequacy of space and proper location, whether or not work is under this Division.

C. Repair or replace, to the satisfaction of the Owner, any damage to work of this Section, damage caused by leaks or breaks in systems of this Section, and damage caused by work of this Section including that to landscaping, paving or other items which are to remain in use.

D. Provide carpentry, masonry, concrete and metal work required for work of this section, except where specifically called for under other Divisions.

E. Provide cutting and patching as required for execution of work performed under this section and not provided under other sections. Normal framing and blocking will be installed under another Division.

F. Valves and trim not specifically indicated, but required for proper functioning of equipment, shall be furnished and installed by the trade installing the equipment.

1.03 PROTECTION, STORAGE AND DELIVERY

A. Provide necessary storage and shop areas at the site for safe and proper storage and use of tools and materials in approved locations which do not interfere with the work. Remove these facilities and restore area(s) to original condition at completion of project.

B. Arrange delivery of products in timely fashion to coordinate with work progress.

C. Immediately upon delivery inspect shipment(s) to assure that products are undamaged and in accordance with specification requirements. Should the product be damaged or not in compliance with requirements, immediately repair as directed or approved or order replacement at no additional cost to the Owner.

D. Replace lost or damaged materials and equipment at no increase in Contract Sum.

E. Protect equipment and materials from physical damage, construction dirt and the elements, from the time they are shipped by the manufacturer to the time the building is accepted by the Owner.

F. Deliver products in the manufacturer's original packaging with identifying labels intact and legible.
Legibly identify units or items as to installation location and/or drawing designations to permit check by Owner’s representative against approved material list and shop drawings.

PART 2 - PRODUCTS

2.01 GENERAL USE VALVES & PIPING SPECIALTIES

A. These include valves manually operated with hand-wheels, levers or other handles.

B. Furnish tee handle operators to suit all valves which are installed below grade in access boxes and which are not fitted with integral handles.

C. Gate Valves:
   1. Shut-off Valves
      a. Class 125, solid wedge gate, Stockham, Milwaukee or Nibco.
      b. Sizes 2½" and smaller: Fig. B-105; bronze body, threaded ends, union bonnet, rising stem.
      c. Sizes 3" and larger: Fig. G-612; iron body, brass mounted, flanged ends, bolted bonnet, non-rising stem.

D. General Use Valves (Plumbing and HVAC); Use manufacturer shown:
   1. Hand: Through 2" Apollo ball valve; 82-100 or Hammond.
   2. Hand: 2½" and larger Demco Series NE-C, Stockham or Keystone butterfly valve, lug body with 416 SS stem, bronze disc. Butterfly valves shall conform to all applicable requirements of AWWA Specification C504 for Class 150 valves, except for face-to-face dimensions. Except where automatic operators are shown on drawings, butterfly valves 4" and smaller shall have lever operator with locking bolt and shall be rated as end of line type valve, valves 6" and larger shall have enclosed, self-locking gear or screw operator and ductile iron disc with nickel plating and shall be rated as an end of line service valve.
   3. Balance: B & G circuit setters where shown or equivalent, Armstrong Series CB and RDB. Provide with pre-formed insulating jacket.
   4. Flanged iron body OS&Y gate valve for systems up to 150 PSI operating pressure. Nibco F637-31 or equal Stockman for valves 2½" and larger.
   5. Check Valves: Milwaukee, Watts or Apollo:
      a. 2" and smaller - Model 509, bronze body threaded ends and cap.
      b. 2½" and larger - Model F2974, iron body, bronze mounted, flanged ends, bolted cap.
   6. Check Valves for water systems 4" and larger: Metraflex Series 900 or Grinnell Series 500 globe style silent check valve, semisteel body with bronze trim, flanged, 150 PSI.

E. Pressure Regulating and Relief Valves:
   1. Pressure Reducing: Bronze Body, Bailey, Cash Acme, or B & G.
   2. Back Pressure Regulating: Bailey #428, 20-60# range, unless noted otherwise; bronze body, Cash Acme or B & G.
   3. Relief Valves: Sarco, Sprague, A.W. Cash, Fisher Controls, or Kunkle as shown on drawings ASME code.

F. Air Vent: Bell & Gossett where automatic type is shown. Install with shut-off valves and drain to a floor sink or drain. Provide 3/8" ball valve for manual air vent at coils and at each high point in piping systems, pipe drain to floor sink or floor drain. Provide 11 in. x 3/8" copper vent with gooseneck.

G. Strainers: Keckley or equal with magnetic screen assembly, "Y" pattern, 250 psi W.P. 40 square mesh screen for sizes 2" and smaller; 1/16" perforated screen for sizes 21/2" through 4", and 1/8" perforated screen for sizes 5" and larger.

H. Install all strainers with a blow-off valve (ball type, Apollo 77-100 or equal). Strainer shall have...
PART 3 - EXECUTION

3.01 COORDINATION

A. Cutting and Repairing: Include in the work all cutting and repairing necessary and required for the installation. Repairing shall be performed by workmen skilled in the trade involved, in a manner satisfactory to the Owner.

B. Congested Areas:
   1. All conditions involving work under this Division and work and other sections shall be worked out in advance of installation. Before work proceeds, prepare supplementary drawings under this Division for approval, showing all work, especially in tight areas. Provide supplementary drawings for additional work necessary to overcome "tight" conditions at no increase in the Contract Sum.
   2. Differences or disputes concerning coordination, interference or extent of work between Sections shall be decided by Owner/General Contractor/Construction Manager.

C. Coordination with other Divisions: Coordinate electrical interlocks of mechanical equipment with the Electrical Division.

D. Provide, to cause no delay, all required sleeves, chases, concrete inserts, anchor bolts, etc., before concrete is poured. Be responsible for correct location and installation of same.

E. Information to Other Divisions: Provide templates, information and instructions to other Divisions to properly locate holes and openings to be cut or provided for Mechanical Work.

3.02 INSTALLATION – VALVES

A. Valves and Strainers:
   1. If no shut-off is indicated, provide a valve at the outlet and the inlet connections to all equipment. Provide the proper valve trim for service intended.
   2. Do not use solder end valves unless noted otherwise; provide threaded or flanged adapters in copper tubing systems.
   3. Provide all valves and strainers, full pipe size unless indicated otherwise.
   4. Provide valves and strainers of the same size as the pipe in which they are mounted unless specifically shown otherwise.
   5. Connect valves and strainers in copper piping systems with solder-to-threaded brass adapters.
   6. Provide valves with trim proper to the service on which they are applied.
   7. Locate above-grade valves
      a. With stems above the horizontal plane of the pipe.
      b. Within six feet of floor where possible and reasonable.
      c. Out from under equipment.
      d. Readily accessible with adequate clearance around operating wheel or lever handle.
      e. Provide chain operator for any valve located at 8’ centerline or higher above floor.
   8. Position below-grade valves in access boxes.
      a. With stem horizontal if fitted with integral operating handle; provide adequate clearance for operation.
      b. With stem upright if fitted for operation by tee handle.
   9. Provide shut-off valves at all inlet connections of fixtures, coils and equipment; on multiple coil banks, provide shut-off valve at the inlet of each coil.
   10. Provide balance valves at all outlet connections of fixtures, coils and equipment in hydronic systems; on multiple coil banks, provide a balance valve at the outlet of each coil.
11. Fit each strainer with globe or ball type blowdown valve sized to match blowdown tapping in screen retainer; run discharge pipe to nearest floor drain or other appropriate discharge point as shown or direct.

B. Instrumentation:
   1. Install all instrumentation items in a location where they are readily viewable and serviceable.
   2. Install gauge cock at all pressure gauges.

END OF SECTION
SECTION 23 05 53
MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Equipment signs.
   4. Access panel and door markers.
   5. Pipe markers.
   7. Valve tags.
   8. Valve schedules.
   9. 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. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE


1.5 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 location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
   1. Terminology: Match schedules as closely as possible.
   2. Data:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
   3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Data: Instructions for operation of equipment and for safety procedures.
   2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
   3. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
   4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
D. Access Panel and Door Markers: 1/16-inch - thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
   1. Colors: Comply with ASME A13.1, unless otherwise indicated.
   2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
   4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
   5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.


E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
   2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 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 markers, equipment markers, equipment signs, and similar operational instructions.
   1. Stencil Material: Aluminum or Brass.
   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.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
   1. Material: 0.032-inch thick brass or aluminum.
   2. Material: 0.0375-inch thick stainless steel.
   4. Valve-Tag Fasteners: Brass wire-link or beaded chain.

2.5 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
   2. Frame: Extruded aluminum.
   3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 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 minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.
3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   2. Expansion tanks, air separators and similar equipment.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. Letter Size: Minimum ¼ inch for name of units if viewing distance is less than 24 inches, ½ 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.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
      b. Fire department hose valves and hose stations.
      c. Meters, gages, thermometers, and similar units.
      d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
      e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
      f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
      g. Fans, blowers, primary balancing dampers, and mixing boxes.
      h. Packaged HVAC central-station and zone-type units.
      i. Tanks and pressure vessels.
      j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated-plastic equipment markers, at Installer’s option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

D. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
1. Identify mechanical equipment with equipment markers in the following color codes:
   a. Green: For cooling equipment and components.
   b. Yellow: For heating equipment and components.
   c. Green and Yellow: For combination cooling and heating equipment and components.
   d. Brown: For energy-reclamation equipment and components.

2. Letter Size: Minimum ¼ inch for name of units if viewing distance is less than 24 inches, ½ 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.

3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

4. Include signs for the following general categories of equipment:
   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
   b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
   c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
   e. Fans, blowers, primary balancing dampers, and mixing boxes.
   f. Packaged HVAC central-station and zone-type units.
   g. Tanks and pressure vessels.
   h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

E. Stenciled Equipment Sign Option: Stenciled signs may be provided instead of laminated-plastic equipment signs, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

F. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
   2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches
wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer’s option. Install stenciled pipe markers complying with ASME A13.1 on each piping system.
   1. Identification Paint: Use for contrasting background.

C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 non-accessible 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.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
   1. Valve-Tag Size and Shape:
      d. Gas: 1-1/2 inches, round.
      e. Steam: 1-1/2 inches, round.
   2. Valve-Tag Color:
      a. Cold Water: Green.
      b. Hot Water: Yellow.
c. Fire Protection: Red.
d. Gas: Yellow.
3. Letter Color:
   d. Gas: White.

3.5 VALVE-SCHEDULE INSTALLATION
   A. Mount valve schedule on wall in accessible location in each major equipment room.

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

3.7 ADJUSTING
   A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING
   A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 23 05 53
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
   1. Balancing airflow including submains, branches, and terminals, to indicated quantities according to specified tolerances.
   2. Adjusting total HVAC systems to provide indicated quantities.
   4. Setting quantitative performance of HVAC equipment.
   5. Verifying that automatic control devices are functioning properly.
   7. Reporting results of activities and procedures specified in this Section.

1.2 DEFINITIONS

C. CTI: Cooling Tower Institute.
E. SMACNA: Sheet Metal and Air Conditioning Contractors’ National Association.

1.3 SUBMITTALS

B. Certified Testing, Adjusting, and Balancing Reports: Prepared on approved forms certified by the testing, adjusting, and balancing Agent.

1.4 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by AABC or NEBB.
B. Certification of Testing, Adjusting, and Balancing Reports: Certify testing, adjusting, and balancing field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that testing, adjusting, and balancing team complied with approved testing, adjusting, and balancing plan and procedures specified and referenced in this Specification.


D. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification" as appropriate.

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by the instrument manufacturer.

1.5 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.6 COORDINATION

A. Coordinate efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. National Project Performance Guarantee: For AABC certified agents, provide a guarantee on AABC’s "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: For NEBB certified agents, provide a guarantee on NEBB forms stating that NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to construction, examine the Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documentation."

D. Examine equipment performance data, including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, flow-control devices and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
J. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.

K. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine equipment for installation and for properly operating safety interlocks and controls.

N. Examine automatic temperature system components to verify the following:
   1. Dampers and other controlled devices operate by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff dampers are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
   9. Interlocked systems are operating.
  10. Changeover from heating to cooling mode occurs according to design values.

O. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Automatic temperature-control systems are operational.
   3. Equipment and duct access doors are securely closed.
   4. Balance, smoke, and fire dampers are open.
   5. Isolating and balancing dampers are open and control dampers are operational.
6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

7. Windows and doors can be closed so design conditions for system operations can be met.

3.3 TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Cooling water flow rate: Plus or minus 5 percent.

3.5 REPORTS

A. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

B. Final Report: Typewritten, or computer printout in letter-quality font, on standard bond paper, bound in three-ring, loose-leaf binder, and tabulated and divided into sections by tested and balanced systems.
   1. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing agent.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Final Report Contents: In addition to certified field report data, include the following:
      a. Fan curves.
      b. Manufacturers' test data.
      c. Field quality-control test reports prepared by system and equipment installers.
      d. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
4. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   a. Title page.
   b. Name and address of testing, adjusting, and balancing Agent.
   c. Project name.
   d. Project location.
   e. Engineer's name and address.
   f. Contractor's name and address.
   g. Report date.
   h. Signature of testing, adjusting, and balancing Agent who certifies the report.
   i. Summary of contents, including the following:
      (1) Design versus final performance.
      (2) Notable characteristics of systems.
      (3) Description of system operation sequence if it varies from the Contract Documents.
   j. Nomenclature sheets for each item of equipment.
   k. Data for terminal units, including manufacturer, type size, and fittings.
   l. Notes to explain why certain final data in the body of reports vary from design values.
   m. Test conditions for fan performance forms, including the following:
      (4) Settings for outside-, return-, and exhaust-air dampers.
      (5) Conditions of filters.
      (6) Fan drive settings, including settings and percentage of maximum pitch diameter.
      (7) Inlet vane settings for variable-air-volume systems.
      (8) Settings for supply-air, static-pressure controller.
      (9) Other system operating conditions that affect performance.

5. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
   a. Quantities of outside, supply, return, and exhaust airflows.
   b. Duct, outlet, and inlet sizes.
   c. Terminal units.
   d. Balancing stations.

3.6 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 05 93
SECTION 230993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. See Division 23 Section "Instrumentation and Control for HVAC” for control equipment and devices and for submittal requirements.

1.2 CHILLED WATER SYSTEM – AIR COOLED CHILLER

A. The chiller and the chilled water pumps are controlled by the DDC system.

B. Chilled water pumps will start through the time schedule program when the outside air temperature is above 65 deg. F. and 20% (adjustable) of chilled water valves are calling for cooling. The status of the pumps will be provided through a current switch at each pump.

C. The DDC system shall monitor the chilled water supply and return temperatures and enable the chiller when the CHW pump is proved on. The chiller through the self-contained factory controls will maintain the setpoint sent from the EMS system.

D. Provide lead-lag software for units having multiple pumps. Should the lead pump fail when commanded on, an alarm will be indicated and the lag pump will start automatically.

E. The following displays/commands to be available at terminal:
   1. Alarm from chiller as inputs.
   2. Current status commanded chiller and pumps.
   3. Chilled water supply temperature.
   4. Chilled water return temperature.
   5. Current switch at each pump.
   6. Pump and chiller runtime totalization (up to 64,000 hours).
   7. Trend logs.
   8. Alarm history.
   9. Lead pump indication.
PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993
PART 1 - GENERAL

1.01 CONDITIONS AND REQUIREMENTS

A. The Drawings and the General Provisions of the Contract including the General Conditions, Supplementary Conditions and Division 1 General Requirements apply to work of this section as fully as if repeated herein.

1.02 INDUSTRY STANDARDS

A. All equipment and materials furnished under this Section and the installation of same shall be in accordance with the rules and regulations of the following:
   1. ASME – American Society of Mechanical Engineers.
   3. SMACNA – Sheet Metal and Air Conditioning Contractors National Association (Seismic Restraint Manual for Mechanical Systems)

1.03 SCOPE OF WORK

A. Provide all labor, equipment and materials that are required to provide a complete installation as indicated on the drawings and in the specifications including that reasonably inferred for proper execution of this Division.

B. Coordinate with work performed under other divisions. Coordinate work done to accommodate requirements of this Division to ensure adequacy of space and proper location, whether or not work is under this Division.

C. Repair or replace, to the satisfaction of the Owner, any damage to work of this Section, damage caused by leaks or breaks in systems of this Section, and damage caused by work of this Section including that to landscaping, paving or other items which are to remain in use.

D. Provide carpentry, masonry, concrete and metal work required for work of this section, except where specifically called for under other Divisions.

E. Provide cutting and patching as required for execution of work performed under this section and not provided under other sections. Normal framing and blocking will be installed under another Division.

F. Valves and trim not specifically indicated, but required for proper functioning of equipment, shall be furnished and installed by the trade installing the equipment.

G. Related work performed under other Sections:
   1. Testing, Adjusting, Balancing: Section 23 05 93.
1.04 PROTECTION, STORAGE AND DELIVERY

A. Provide necessary storage and shop areas at the site for safe and proper storage and use of tools and materials in approved locations which do not interfere with the work. Remove these facilities and restore area(s) to original condition at completion of project.

B. Arrange delivery of products in timely fashion to coordinate with work progress.

C. Immediately upon delivery inspect shipment(s) to assure that products are undamaged and in accordance with specification requirements. Should the product be damaged or not in compliance with requirements, immediately repair as directed or approved or order replacement at no additional cost to the Owner.

D. Replace lost or damaged materials and equipment at no increase in Contract Sum.

E. Protect equipment and materials from physical damage, construction dirt and the elements, from the time they are shipped by the manufacturer to the time the building is accepted by the Owner.

F. Deliver products in the manufacturer’s original packaging with identifying labels intact and legible. Legibly identify units or items as to installation location and/or drawing designations to permit check by Owner’s representative against approved material list and shop drawings.

1.05 QUALITY ASSURANCE

A. Employ only qualified and experienced personnel skilled in the trade(s) included in work of this division.

B. Perform all tests required on the systems. Prepare test reports as required, obtain proper approvals and submit final reports to the Owner’s representative.

C. Coordinate all work specified herein with work of other sections and divisions.

PART 2 - PRODUCTS

2.01 PIPE PRESSURE

A. Copper: Seamless type K or L, hard drawn, conforming to ASTM Specification B-88.

B. Steel: Schedule 40, black or galvanized conforming to ASTM Specifications A-53.

C. Refrigerant: ACR - Manufactured in accordance with ASTM Standard B280.

2.02 PIPE FITTINGS – PRESSURE

A. Copper - Wrought copper solder type per ANSI Standard B16.22 or cast red bronze per ANSI Standard B16.18.

B. Threaded: AAR Class 300 malleable iron for unions and Class 150 malleable iron for all
other fittings. Material shall correspond to ASTM Specification A-197. Galvanized or black to match pipe.

C. Grooved: Class 150 malleable iron conforming to ASTM Specification A-47.


E. Welded: Standard weight black steel butt welding fittings, permanently marked, conforming to ASTM Specifications A-234. No miters are permitted.

F. Weldolets: Use only where main is at least three sizes larger than branch. Select Weldolet to suit main. Provide smooth beveled openings Bonney Forge or Tube-turns.

G. Refrigerant: Refrigerant piping shall be brazed with high temperature silver solder under a nitrogen purge.

2.03 PIPE JOINTS – PRESSURE

A. Soldered - Lead free - Silvabrite 100, Bridgit, or 95% tin, 5% antimony solder with non-corrosive flux for pipe sizes 2” and smaller, and 15% silver brazing alloy and silver brazing flux on pipe size 2½” and larger or below grade.

B. Gasketed - Neoprene compression gasket with lubricant installed per manufacturer’s recommendations.

C. Screwed Metallic Pipe: Apply Rectorseal No. 5 lubricant and Permacel, P-412 ½” wide white Teflon pipe joint sealant tape to male pipe threads when making up joints.

D. Welded Piping: Use electric arc process. All welding shall conform to the ASME Code for Pressure Piping. Furnish current certification from an approved testing agency or National Certified Pipe Welding Bureau that the welders performing the work are qualified.


F. Grooved: Malleable iron conforming to ASTM Specification A-47. Victaulic Style 77. Standard or Victaulic 07, or equal Gustin-Bacon, with Grade E synthetic gasket, cad plated or galvanized oval neck track bolts and nuts for special grooved end pipe. Use pipe grooving tool specifically designed for this system.

G. Unions:
   1. Steel pipe: 250 lb. bronze to iron ground joint.
   2. Copper tubing: Bronze IPS unions with copper to IPS adaptors.

2.04 PIPE MATERIAL APPLICATION

A. Chilled water, ASTM A-53A ERW or seamless schedule 40 black steel pipe and fittings.
Use threaded pipe and fittings thru 2”; 2 ½” and larger shall be welded. Victaulic piping systems may be used at contractor’s option for chilled water pipe 10” and smaller only. Victaulic piping shall not be used for hot water piping.

B. Cooling coil condensate drainage piping: Type DWV hard drawn copper with wrought copper fittings.

C. Air vents: Type “M” copper.

D. Non-Potable water: Type L hard-drawn copper tubing per ASTM B-88 plain ends with wrought copper solder fittings per ANSI STD B16.22. 20% silver brazing alloy joining materials. Non-Potable water to be soldered as per Section 22.05.00.


2.05 VALVE APPLICATION

A. See Section 23 05 23 for a complete description of the valves.
   1. Chilled Water and Hot Water:
      a. 2” and smaller: Ball valve, inline lift check.
      b. 2 ½” and larger: Lug style butterfly valve (drilled and tapped), inline lift check and globe style silent check valve.

B. Provide balancing valves where indicated on the drawings and where required to properly balance the systems as per Section 2305 93.

2.06 PIPE ACCESSORIES

Refer to Section 23 05 00 for a complete description.

2.07 AIR SEPARATOR: Bell & Gosset Rolairtrol

A. Furnish an air separator as described below. Air separator shall be external air separation units consisting of a tank which shall have flanged tangential inlet and outlet connections and internal perforated stainless steel air collector tube designed to direct released air into the air vent. Unit must be constructed in accordance with ASME boiler and pressure vessel code and stamped 125 PSIG design pressure. A blow-down connection shall be provided to facilitate routine cleaning of the unit.

2.08 EXPANSION TANKS

A. Furnish and install as scheduled on the drawings. Tanks shall be diaphragm-type expansion tank of welded steel construction, and shall be tested and stamped in accordance with Section VIII of the ASME Code for 125 psi. Tank shall be supported by steel legs or a base for vertical installation or steel saddles for horizontal installations.

2.09 CHEMICAL POT FEEDERS

A. Provide a bypass type chemical feeder (Wingert Model 5) and sight glass. Feeder shall have a 3½” quick opening access port for chemical insertion. Unit shall be adequately sized for volume of water in system, but in no case shall be less than 5 gallon capacity.
Unit shall be complete with inlet, outlet and drain tappings.

PART 3 - EXECUTION

3.01 COORDINATION

A. Cutting and Repairing: Include in the work all cutting and repairing necessary and required for the installation. Repairing shall be performed by workmen skilled in the trade involved, in a manner satisfactory to the Owner.

B. Congested Areas:
   1. All conditions involving work under this Division and work and other sections shall be worked out in advance of installation. Before work proceeds, prepare supplementary drawings under this Division for approval, showing all work, especially in tight areas. Provide supplementary drawings for additional work necessary to overcome "tight" conditions at no increase in the Contract Sum.
   2. Differences or disputes concerning coordination, interference or extent of work between Sections shall be decided by Owner/General Contractor/Construction Manager.

C. Coordination with other Divisions: Coordinate electrical interlocks of mechanical equipment with the Electrical Division 26.

D. Provide, to cause no delay, all required sleeves, chases, concrete inserts, anchor bolts, etc., before concrete is poured. Be responsible for correct location and installation of same.

E. Information to Other Divisions: Provide templates, information and instructions to other Divisions to properly locate holes and openings to be cut or provided for Mechanical Work.

3.02 GENERAL PIPING REQUIREMENTS

A. Size any section of pipe for which the size is not indicated, or any intermediate section erroneously shown undersized, the same size as the largest pipe connecting to it. Sizes listed are nominal.

B. Cut piping accurately to job measurements and install it without springing or forcing, true to line and grade, generally square with building and adequately supported to prevent sagging or undue stress on pipe, fittings and accessories.

C. Install dielectric unions or flanges at points of connection between copper brass piping and steel or cast iron pipe or other dissimilar materials. Plastic insert in unions are not acceptable.

D. Provide unions at connections to the equipment, on both sides of control valves and elsewhere as required to facilitate maintenance.

E. Make changes in size or direction with manufactured fittings. The use of bushings, reducing flanges or bending of a pipe is not allowed.
F. Install piping full size through shut-off valves, balancing valves, etc. Change pipe size within three pipe size diameters of the final connection to fixtures and equipment.

G. Seal all pipes penetrating through roof with “Stoneman” Series 900 or 1100-4 at all other piping penetrations through the roof.

H. Provide appropriate manufactured adaptors when two different piping materials are connected.

I. Do not cover or enclose the piping work before it has been cleaned, tested, inspected and approved by the Architect.

J. Flush all pipes free from foreign substances before installing valves, stops or making final connections.

K. Use flexible connectors at connections to all vibrating equipment and where specifically called for on the drawings.

L. Provide chrome plated escutcheons for piping penetrations through walls or ceilings that are exposed to view. Split ring type escutcheons are not acceptable.

M. Arrange piping and hangers to allow for expansion, contraction and structural settlement. Do not install piping in contact with the building structure. Provide piping subject to expansion or contraction with anchors and expansion loops or joints as required. Provide adequate anchors and guides to prevent misalignment.

N. Where pipes pass through sleeves or core drilled holes, provide backer rod and fill outer 1/2” depth of the annular space with sealant.

O. Core drilling: Provide all equipment, labor and material for core drilling holes where piping penetrates existing concrete walls or floors. Drill holes 1” larger than O.D. of pipe, except where sizes are noted. Verify the location of every core drilled hole with the Owner. Protect all surrounding areas from damage by water or dust while core drilling. Where pipes pass through sleeves or core drilled holes, provide backer rod and fill outer 1/2” depth of the annular space with sealer.

P. Should structural conditions or other work such as ducts, conduits, lights, etc., prevent the installation of pipes or the setting of equipment at the points indicated on the drawings, changes as authorized by the Architect shall be made without additional cost to the Owner. All piping shall be concealed unless specifically indicated or directed otherwise. Install piping parallel to building surfaces with a minimum of fittings.

Q. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of the installation.

R. Pipe the discharge of each relief valve, air vent, and similar device to floor sink, floor drain, exterior or other acceptable location whether indicated or not on the drawings, except in attics and ceiling spaces. Install a union on discharge of each relief valve.

S. Provide swing joint at all hot water piping connections to equipment.
T. Install piping at heat exchangers, coils, etc., so that equipment can be removed and/or serviced with a minimum of pipe dislocation. All fittings, etc., shall be readily accessible. All service valves to equipment shall be located in such a manner to allow equipment maintenance and tear down without having to remove service valves.

U. Use standard elbows, tees, etc. as specified for each system.

3.03 PIPE ACCESSORIES

A. Install valves, strainers, gauges, thermometers and other pipeline accessories where indicated on the drawings. Temperature control elements will be furnished by Instrumentation and controls herein. Refer to Section 23.09.00.

3.04 SYSTEM CLEANING FOR MECHANICAL PIPING

A. Mechanical Contractor:
   1. General: Prior to permanent installation, all pipes shall be cleaned of foreign objects, debris and dirt.
   2. Coordination: Coordinate all system flushing with cleaning contractor and Owner representative.
   3. Flushing: Thoroughly flush piping system with water just prior to the cleaning contractor chemical cleaning of a system, coordinate with cleaning contractor. Flushing of the system is to remove final objects and oils from piping after installation, but is not a substitute for cleaning a pipe prior to installing. Remove all strainers and clean prior to chemical cleaning. Assist the cleaning contractor in refilling the chemical cleaning. Assist the cleaning contractor in refilling the system with water to clean the system. Note that any time water is introduced into a system, it shall be kept full of water from that point on, with the exception of bleeding water off for testing purposes or flushing. Under no circumstances shall the system be left void of water for more than six hours. The mechanical contractor is to clean all strainers and hydro test the system after the cleaning contractor is done chemically and has flushed the system just prior to final chemical additives being introduced to the system. Repair any leaks found in the system and retest as needed until hydrostatic test holds.

B. Cleaning Contractor
   1. General: Provide all labor, materials and equipment, including pumps, tanks and water heaters as necessary to complete mechanical systems cleaning.
   2. Coordination: Coordinate with mechanical contractor all schedules and dates. Notify Owner of date and times.
      a. Chemical cleaning: Provide chemicals and thoroughly clean system. Flush system free of all cleaning chemicals. Use no solvents in system cleaning. Use only normally accepted and environmentally safe and acceptable chemicals which would be introduced into any waste system. Use degreasing and deoiling agents in conjunction with passivating chemicals. Circulate cleaning agent for not less than twelve hours at not less than 3 feet per second. Treat all water as necessary to meet local/state/federal codes prior to putting the water to a waste system.
b. System flushing and treating: Immediately after system cleaning, flush system. Coordinate with mechanical contractor, assist mechanical contractor with strainer cleaning and hydrostatic test of system. Assist in refilling system and add corrosion inhibitions to system and chemically balance system to 7.5 to 7.8 pH, or so that it is compatible with any other system with which it will operate. Circulate chemical in system for not less than two hours to assure complete mixing.

3.05 PIPE TESTING

A. Test all piping as noted below with no leak or loss of pressure. Repair or replace defective piping until tests are accomplished successfully.

<table>
<thead>
<tr>
<th>System</th>
<th>Test Pressure</th>
<th>Test Medium</th>
<th>Test Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensate Drains</td>
<td>10 Ft.Hd.</td>
<td>water</td>
<td>4 hours</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>150PSIG</td>
<td>water</td>
<td>8 hours</td>
</tr>
</tbody>
</table>

3.06 PIPE AND EQUIPMENT IDENTIFICATION

A. Refer to Section 23 05 53 for all requirements.

END OF SECTION
PART 1 - GENERAL

1.01 CONDITIONS AND REQUIREMENTS

A. Refer to the General Conditions, Supplementary Conditions, Division 1 General Requirements, and Section 23.05.13.

1.02 INDUSTRY STANDARDS

A. All equipment and materials furnished under this Section and the installation of same shall be in accordance with the rules and regulations of the following:
   1. ASME – American Society of Mechanical Engineers.
   3. SMACNA – Sheet Metal and Air Conditioning Contractors National Association (Seismic Restraint Manual for Mechanical Systems)

1.03 SCOPE OF WORK

A. Provide any incidental work not shown or specified that is necessary to provide a complete system

B. Related work performed under other Sections:
   1. Testing, Adjusting, Balancing: Section 23.05.93.
   4. Seismic Control: Section 23.05.48.

1.04 MATERIAL HANDLING AND STORAGE

A. The contractor shall be responsible for the timely delivery of equipment and materials to meet the project and construction schedule. The contractor shall be responsible for but not limited to the following:
   1. The contractor shall receive all equipment and materials in undamaged factory packaging, store, protect, maintain, rig and install equipment in place.
   2. The contractor shall set the equipment in place and make all connections as required to provide a complete installation and functional system.

B. Store all equipment and materials on site in areas designated by the general contractor. Provide all means possible to protect equipment from intrusion of dirt or damage prior to, during and after installation.

1.05 QUALITY ASSURANCE

A. Employ only qualified and experienced personnel skilled in the trade(s) included in work of this division.

B. Perform all tests required on the systems. Prepare test reports as required, obtain proper approvals and submit final reports to the Owner’s representative.

C. Coordinate all work specified herein with work of other sections and divisions.

PART 2 – PRODUCTS
2.01 PUMPS

A. General:
   1. All rotating parts shall be statically and dynamically balanced to meet Table 46, Chapter 48 ASHRAE Applications 2011.
   2. Provide flanged connections on all pumps. Pump connections shall be full size of specified pumps.
   3. Pumps shall have ventilated bearing housing unless direct mounted to motor.
   4. Flexible coupling shall have a guard to comply with OSHA.
   5. Unless noted otherwise, pumps shall have mechanical seals suitable for the temperature and fluid handled.
   6. The pumps shall be factory tested.

B. End Suction Pumps: B & G, PACO, TACO, or Equal.
   1. Pumps shall be end suction, centrifugal type and shall have ball bearings, grease lubricated, mounted in housings, with a grease fitting on the bearing housing. Bearing housings shall be watertight with water deflectors or seals to prevent water from entering the bearing housing.
   2. The pump volute shall be supplied with plugged vent, drain and gauge tappings.
   3. The shaft shall be of 18-8 M stainless steel on standard mechanical seal models, and of alloy steel with replaceable 18-8 M stainless steel sleeves on stuffing box models.
   4. A flexible non-lubricated coupling of the center drop-out type shall be furnished, capable of withstanding all types and combinations of shock, misalignment, and end float.
   5. The pump and motor shall be mounted on a common baseplate of heavy structural steel design with securely welded crossmembers and open grouting area.
   6. Pumps shall have a cast iron casing with smooth passageways, capable of withstanding a hydrostatic test pressure 150% of the maximum pumping pressure under which the pump could operate at design speed. Suction and discharge connections shall be located in the casing so as to allow removal of the rotating element without disturbing the piping connections. Provide bronze casing wearing rings locked to the casing to prevent movement.
   7. The impeller shall be made of cast bronze, accurately keyed to the shaft and secured with a lock nut. The shaft shall be stainless steel. Impeller shall be trimmed to obtain the desired water flow.
   8. Capacities and operating conditions shall be as indicated on the drawing schedules.

2.02 SUCTION DIFFUSERS

A. Acceptable Manufacturers: B&G, Armstrong, TACO or equal.

B. Suction diffusers shall consist of an angle type cast iron body with straightening vanes and combination diffuser strainer/orifice cylinder with 3/16” openings for pump protection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. Orifice cylinder shall be designed to withstand 150 psig system working pressure. Provide unit with 16 mesh stainless steel strainer to be removed after system startup. Unit shall also be provided with adjustable support foot to carry weight of suction piping.

PART 3 – EXECUTION

3.01 PUMPS

A. Pump and motor shall be aligned by pump manufacturer.
B. Support all piping from the building structure to prevent any strain on the pump casings. Check alignment of the piping connections and motor coupling after pumps have been secured to their base.

C. Pumps shall have non-overloading characteristics. Motor shall not be operated above its nameplate horsepower rating, operation in service factor range will not be allowed under any operating conditions.

D. Increase piping immediately at pump suction and discharge using concentric reducers. Couplings and all valves shall be full line size.

E. The motor housing shall be cast iron with factory installed junction box and shall be NEMA labeled.

F. Provide temperature and pressure test plugs on the suction & discharge of each pump.

G. Provide pressure gauge with gauge cocks on the suction & discharge piping at each pump.

END OF SECTION
PART 1 - GENERAL

1.01 CONDITIONS AND REQUIREMENTS
   A. Refer to the General Conditions, Supplementary Conditions, Division 01 General Requirements and Sections 23 05 00 and 23 21 13.

1.02 INDUSTRY STANDARDS
   A. All equipment and materials furnished under this Section and the installation of same shall be in accordance with the following standards:
      1. Chillers: ASME Unfired Pressure Vessel Code, rated in accordance with ARI.
      2. Unit shall be rated in accordance with ARI Standard 590, latest revision (U.S.A.).
      3. Unit construction shall comply with ASHRAE 15 Safety Code, NEC, and ASME applicable codes (U.S.A. codes).
      4. Unit shall be manufactured in a facility registered to ISO 9002/BS5750.
      5. Unit shall be full load run tested at the factory.

1.2 SCOPE OF WORK
   A. Furnish and install all refrigeration equipment and associated appurtenances as indicated on the drawings and specified herein. Also provide any incidental work not shown or specified that is necessary to provide a complete system. This includes but is not limited to the following:
      1. Placement of chiller and associated expansion tanks, pumps and air purge units.
      2. Connection of piping mains, relief valves, make up water, etc.
      3. Removal of debris and clean up of all equipment before final acceptance of owner. Keep all work areas clean and orderly throughout construction.

   B. The following related work is described/ performed under other Sections:
       1. HVAC Insulation - Section 23 07 00.
       2. Piping systems - Section 23 05 00 and 23 21 13.
       3. Controls - Section 23 09 00.

1.3 MATERIAL HANDLING AND STORAGE
   A. The Contractor shall receive, store, protect, maintain and rig.
   B. The contractor shall set the equipment in place and make all connections as required to provide a complete installation and functional system.
   C. The contractor shall review the equipment submittals and shall provide all parts, connections, controls and devices not specifically listed therein, nor supplied, that are necessary or required to make the system and installation complete and functional.
   D. Store all equipment on site in areas designated by the general contractor. Provide all means possible to protect equipment intrusion of dirt or damage prior to, during and after installation. Unit controls shall be capable of withstanding 150°F storage temperatures in the control compartment. Units shall be stored and handled per unit manufacturer’s recommendations.
PART 2 - PRODUCTS

2.01 AIR COOLED CHILLERS: Carrier, Trane, or York

A. Air Cooled Chillers
   1. General
      a. The contractor shall furnish and install air-cooled water chillers as shown as scheduled on
         the contract documents. The chillers shall be installed in accordance with this specification
         and perform at the specified conditions as scheduled.
   2. Compressors
      a. Construct chiller using fully-hermetic, direct-drive, scroll type compressors.
      b. Compressor motors shall be cooled by refrigerant gas passing through motor windings
         and shall have either internal line break thermal and current overload protection or
         external current overload modules with compressor temperature sensors.
      c. Compressors shall be mounted on rubber in shear vibration isolators.
      d. Statically and dynamically balance rotating parts.
      e. Staging of compressors shall provide unloading capability.
   3. Evaporator
      a. Provide shell and tube type evaporator, single-pass, ANSI (American National Standards
         Institute) type 316 stainless steel, brazed plate construction.
      b. Design, test, and stamp refrigerant side for 450 psig working pressure and water side for
         300 psig working pressure, in accordance with ANSI/ASME SEC 8.
      c. Provide water drain connection, vent and fittings for factory installed leaving water
         temperature control and low temperature cutout sensors.
      d. Evaporator shall have factory-installed heater, to protect cooler from ambient temperature
         freeze down to -20 F.
      e. Unit shall be provided with a factory-installed flow switch.
      f. Water inlet line shall have 40 mesh strainer just ahead of evaporator.
   4. Condenser And Fans
      a. Chiller shall be able to operate in ambient conditions of -20 degrees F.
      b. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum
         alloys for fins, copper tubes, and manifolds in combination with a corrosion-resistant
         coating. Coil shall be air-cooled Novation® heat exchanger technology with microchannel
         (MCHX) coils.
      c. Provide coil protection for shipping. Entire condenser coil shall be covered with heavy
         plastic to prevent inadvertent damage to coil during shipment or rigging.
      d. Assembled condenser coils shall be leak tested and pressure tested at 656 psig.
      e. Tubes shall be cleaned, dehydrated, and sealed.
      f. Condenser fans shall be direct-drive Aero- Acoustic™ type, discharging air vertically
         upward.
      g. All condenser fan motors shall be totally enclosed 3-phase type with permanently
         lubricated ball bearings, Class F insulation and internal, automatic reset thermal overload
         protection or manual reset calibrated circuit breakers.
      h. Shafts shall have inherent corrosion resistance. Fan blades shall be statically and
         dynamically balanced. Condenser fan openings shall be equipped with PVC coated steel
         wire safety guards.
   5. Enclosures
      a. House components in 12 gauge galvanized steel frame and mounted on welded structural
         steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc.
      b. Unit panels and control panels shall be finished with a baked on powder paint. Control
         panel doors shall have door stays.
      c. Mount starters and disconnects in weatherproof panel provided with full opening access
         doors. Provide lockable through-the-door disconnect operating handle external to panel
and clearly visible from outside of unit indicating if power is on or off.
d. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117.
e. Security Grilles/Hail Guards: Unit shall be supplied with factory or field-installed, louvered, sheet metal panels which securely fasten to the chiller and provide condenser coil protection against hail and other physical damage.

6. Refrigerant Circuit
a. All units have 1 refrigeration circuit. Refrigerant circuit components shall include filter drier, moisture indicating sight glass, electronic expansion device and complete operating charge of both refrigerant R-410A and compressor oil.

7. Controls
Chilled water temperature control shall be microprocessor-based with non-volatile memory, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Microprocessor Battery backup system shall not be accepted.
a. Unit controls shall include the following minimum components:
   1) Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
   2) Separate terminal block for power and controls.
   3) Control transformer to serve all controllers, relays, and control components.
   4) ON/OFF control switch.
   5) Replaceable solid-state controllers.
   6) Pressure sensors shall be installed to measure suction and discharge pressure for each circuit. Thermistors shall be installed to measure cooler entering and leaving fluid temperatures, outdoor ambient temperature, and suction temperature. Provision for field installation of accessory sensor to measure compressor return gas temperature.

b. Unit controls shall include the following functions:
   1) Hermetic scroll compressors auto-adaptive control that minimizes compressor wear.
   2) Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1° F.
   3) Limiting the chilled fluid temperature pulldown rate at start-up to an adjustable range of 0.2° F to 2° F per minute to prevent excessive demand spikes at start-up.
   4) Seven-day time schedule.
   5) Leaving chilled fluid temperature reset from return fluid and outside air temperature.
   6) Chilled water pump start/stop control and primary/standby sequencing to ensure equal pump run time.
   7) Timed maintenance scheduling to signal maintenance activities for condenser coil cleanings, strainer maintenance and user-defined maintenance activities.
   8) Low ambient protection to energize cooler and hydronic system heaters.
   9) Single step demand limit control activated by remote contact closure.
   10) Nighttime sound mode to reduce the sound of the machine by a user-defined schedule.

c. Diagnostics:
   1) The control panel shall include, as standard, a scrolling marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.
2) Information included for display shall be:
   a) Compressor lockout.
   b) Loss of charge.
   c) Low fluid flow.
   d) Cooler freeze protection.
   e) Cooler set point.
   f) Chilled water reset parameters.
   g) Thermistor and transducer malfunction.
   h) Entering and leaving-fluid temperature.
   i) Compressor suction temperature.
   j) Evaporator and condenser pressure.
   k) System refrigerant temperatures.
   l) Chiller run hours.
   m) Compressor run hours.
   n) Compressor number of starts.
   o) Low superheat.
   p) Time of day:
      • Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
      • Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
      • An alarm history buffer shall allow the user to store no less than 20 alarm events with clear language descriptions, time and date stamp event entry.
      • The chiller controller shall include multiple connection ports for communicating with the local equipment network, the Carrier Comfort Network® (CCN) system and access to chiller control functions from any point on the chiller.
      • The control system shall allow software upgrade without the need for new hardware modules.

    d. Safeties:
       1) Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
          a) Loss of refrigerant charge.
          b) Reverse rotation.
          c) Low chilled fluid temperature.
          d) Thermal overload.
          e) High pressure.
          f) Electrical overload.

PART 3 - EXECUTION

3.01 GENERAL

   A. Refer to Section 23 05 00 for general installation requirements.

3.02 EQUIPMENT INSTALLATION

   A. Set all equipment in a place allowing for easy access to all parts of the equipment. Do not block access to any access doors, pull spaces or parts requiring access for maintenance.
B. Provide all anchors and supports for proper installation on equipment. Unless noted otherwise, all materials used for anchoring and supports shall be galvanized.

D. Provide power filter, if required, to meet or exceed IEEE Standard 519, Tables 10.2 & 10.3.

3.03 EQUIPMENT IDENTIFICATION

A. Refer to Section 23 05 53.

3.06 MAINTENANCE SCHEDULE

A. Equipment manufacturers shall submit information pertaining to maintenance. A lubrication schedule, along with anticipated bearing life, shall be part of this package. Reliability and low maintenance will be a strong consideration in equipment selection.

END OF SECTION