PROJECT SPECIFICATION MANUAL

Houston Community College - Stafford Fine Arts Building
9910 Cash Road, Stafford, TX 77477

Chiller Replacement Project 2016

Prepared for:

Houston Community College
3100 Main Street
Houston, Texas 77002

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SECTION 26 05 01 SELECTIVE DEMOLITION

1.0 GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of contract, including General and Supplementary Conditions. Specification sections apply to the work of this section.

1.2 DESCRIPTION OF WORK:

A. Extent of selective demolition is indicated on drawings.

1.3 TYPES OF SELECTIVE DEMOLITION WORK:

A. Demolition requires the selective removal of existing building materials and equipment that is no longer required. Houston Community College will provide dumpsters for materials and equipment that is removed from the building for recycling by HCC. All other trash, debris, materials and equipment not deposited in the HCC dumpsters by the Contractor will be removed from the property and properly disposed by the Contractor in accordance with all federal, state and local laws and regulations. Upon request by HCC, the Contractor shall furnish signed, written documentation of evidence verifying proper disposal.

B. Contractor shall visit the site prior to bid and compare the new project documents to existing conditions and include in his bid items required to be removed, relocated and re-installed to accommodate the installation of new equipment.

C. Related work specified elsewhere:

1) Remodeling construction work and patching is included within the respective sections of specifications, including the removal of materials for re-use and incorporated into remodeling or new construction.

2) Relocation of pipes, conduits, ducts, and other mechanical or electrical work are specified by respective trades.

3) Should any asbestos containing material be encountered, contractor shall stop work immediately and contact the Owner and the Owner's representative before proceeding with work. The cost of asbestos abatement and removal is not included as part of this contract. The Owner will provide separate contractors for this work should it be required. However, should the contractor fail to comply with above stated requirements, he/she will be charged the costs incurred to the Owner for the asbestos cleanup process due to the contractor's actions in disturbing asbestos containing materials. Contact the Owner regarding any asbestos information required for this project.

1.4 SUBMITTALS:

A. Schedule – Submit a schedule indicating proposed methods and sequence of operations for selective demolition work to the Owner's representative for review prior to commencement of work. Include coordination for shut-off, capping, continuation of services, noise protection, and dust control details as required.

B. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of the Owner's onsite operations.

1.5 JOB CONDITIONS:

A. Owner may be continuously occupying areas of the building. Conduct selective demolition work in a manner that will minimize need for disruption of the Owner's normal operations. Provide a minimum 72 hour advance notice to the Owner of demolition activities which will impact the Owner's operations.

B. Condition of Structures - Owner and Engineer assume no responsibility for actual conditions of items or structures to be demolished.

C. Partial Demolition and Removal - Items indicated to be removed but of salvable value to contractor and not elected to be retained by Owner, may be removed from structure as work progresses. Transport salvage items from site as they are removed.

D. Storage and sale of removed items on-site will not be permitted.

E. Provide temporary barricades and other forms of protection as required to protect Owner's personnel and general public from injury due to selective demolition.

F. Provide protective measures as required to provide free and safe passage of Owner's personnel and general public to and from occupied areas.

G. Erect temporary covered passageways as required by Authorities Having Jurisdiction.

H. Provide interior and exterior shoring, bracing, and support to prevent movement, settlement, and collapse of structure/element to be demolished and work to remain after demolition.

I. Protect from damage any finish work that is to remain in place and becomes exposed during the demolition process.

J. Protect floors with suitable covering when necessary.

K. Protect all equipment, furnishings and Owner's property.

L. Construct temporary insulated solid dustproof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip with dustproof doors and security locks if needed.

M. Provide temporary weather protection to insure that no water leakage or damage occurs to structure or interior areas of existing buildings.

N. Remove protections at the completion of the work.

O. Promptly repair damage caused to adjacent facilities by demolition work at no cost to the Owner.

P. Traffic - Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walkways, and other adjacent facilities.

Q. Explosives/Fires - Use of explosives or fires will not be permitted.

R. Utility Services - Maintain existing utilities and keep all in service and operational. Protect against damage during demolition operations.

S. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by those having jurisdiction. Provide temporary services during interruptions to existing utilities, as required by and acceptable to the Owner and utility suppliers.

T. Environmental Control/Protection- Comply with governing regulations.

2.0 EXECUTION

2.1 EXAMINATION AND PREPARATION:

A. Visit the site prior to bid and start of construction to determine the existing condition of the building including existing mechanical, electrical, plumbing, and special systems. Contractor will be responsible for reviewing any documents which reflect existing conditions.

B. Provide the Owner a written list of any uncovered or surveyed construction and/or code deficiencies not indicated on the documents. Obtain written direction from the Owner on how address deficiencies prior to starting any work.

C. Contractor shall plan any necessary utility shut-off. Contractor shall prepare a written procedure and timeline to be followed for each shut-off to complete the planned work. Contractor shall provide Owner/Engineer details of utility interruption locations and shall coordinate with the Owner to determine timeline for all outages.

D. Verify and/or determine existing circuiting/wiring arrangements for all equipment to be removed, including fire alarm, security, public address, data, telephone, BMS, special systems etc., before de-energizing/disabling any wiring/circuits. Existing circuit/wiring for equipment to be removed or replaced shall be circuit traced to determine panel connections. Verify that abandoned wiring and equipment serve only abandoned facilities and areas.

E. The contractor shall note any existing fire rating/prevention methods employed at each facility - fire caulk, lighting fixture "fire boxes", etc. Maintain and/or restore the original fire rating (using same method as originally provided) at each location affected by the work performed in this renovation. Final installation approval shall be by the AHJ and the Owner.

F. Immediately notify the Owner of any discovered facility deficiencies that could potentially cause a life safety hazard to building occupants. For example, equipment not properly supported, broken ceiling grids or tiles, damaged equipment, exposed conductors, etc. After notifying the Owner, wait for a notice of how to proceed prior to working in the affected area.

G. Contractor shall maintain access to existing electrical equipment or devices which remain active. Contractor shall extend installations using materials and methods specified.

H. Maintain electrical service, air conditioning, fire alarm system, telephone system, and other systems in areas deemed critical to be operational by Owner or Engineer in service until new system is ready to operate. Minimize the duration time of outage by only disabling the systems when performing the switchover and connections to the new system.

I. Beginning of demolition indicates that Contractor accepts existing conditions. No additional project time or additional money shall be allowed for issues arising from coordination with existing conditions upon submission of Bid.

2.2 DEMOLITION:

A. Perform selective demolition work in a systematic manner. Use methods as required to complete work indicated on drawings in accordance with demolition schedule and governing regulations.

B. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power driven masonry saw or hand tools; do not use power driven impact tools.

C. Promptly remove debris to avoid imposing excessive loads on supporting walls, floors or framing.

D. Provide services for effective air and water pollution control as required by local, state, and federal authorities having jurisdiction.

E. Submit a detailed written report to the Owner if any unanticipated problems are found which conflict with the intended function of the design. After notifying the Owner, wait for a notice of how to proceed prior to working in the affected area. Reschedule the selective demolition agenda as necessary to proceed with work and overall progress without delay.

F. Upon completion of renovation, contractor shall provide continuity of any wiring/circuits to existing outlets or equipment to remain including fire alarm, security, BMS, PA, special systems that may have been interrupted due to the demolition of walls or the removal of existing devices. Contractor shall circuit trace all existing devices and equipment to remain to confirm panel/interface and terminal/circuit number, provide ‘as built’ drawings indicating final circuiting. New type written panel directories shall be provided for existing panels and shall be corrected to reflect circuiting changes due to renovation.

G. Contractor shall disconnect and remove equipment no longer indicated on the new project documents and/or abandoned, including supports, hangers and other accessories.

H. Contractor shall remove abandoned piping and conduit, including abandoned piping and conduit above accessible ceiling finishes. Contractor shall cut piping and conduit flush with walls and floors. Contractor shall patch surfaces to match existing.

I. Contractor shall disconnect and remove devices, appliances, and outlets no longer indicated on the new project documents and/or abandoned, including power, fire alarm, communication, security, special systems, etc, in walls or ceilings shown to remain. Contractor shall remove abandoned outlet boxes if conduit servicing them is abandoned and removed. Contractor shall provide a blank cover to match existing/new types, for all outlet boxes not removed.

J. Contractor shall be responsible for confirming all power and low voltage wiring including special systems (fire alarm, security, intercom, data, telephone, etc.) remaining in renovated areas is active upon completion of renovation. Any existing wiring which is inactive and not required shall be removed back to its panel or source.

K. Contractor shall remove, relocate and extend existing electrical/fire/security/intercom/PA/etc. systems to accommodate new construction. All work to be performed on energized equipment or circuits shall be by qualified personnel. Work required for special systems (fire alarm, security, etc) to be performed by qualified personnel certified for these systems.

L. Contractor shall use any existing equipment or building standard vendors as necessary to modify existing equipment due to demolition to insure proper, continuing operation of equipment or systems which have been affected by the demolition but must remain operational. System vendors shall include, but not be limited to, fire alarm, BMS, security, and data/telephone.

2.3 DISPOSAL OF DEMOLITION MATERIALS:

A. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws and ordinances concerning removal handling and protection against exposure or environmental pollution. If asbestos is encountered, do not disturb it, contact the Owner immediately.

B. Refrigerants shall not be released into the environment. Refrigerants shall be captured, stored, transported, and handled in a legal manner. Documentation indicating legal refrigerant disposal shall be presented to the Owner.

C. Remove debris, rubbish, and other materials resulting from demolition operations from building site.

D. All materials and equipment being removed by the Contractor and deemed unwanted by the Owner becomes property of the Contractor and shall be removed from the premises and disposed of by recycling or other environmentally safe manner.

2.4 CLEAN-UP AND REPAIR:

A. Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protections and sweep clean all interior areas.

B. Contractor shall clean and repair existing material and equipment or devices which remain and/or to be reused. Contractor shall restore any damaged material, equipment, and/or finishes to remain to original condition upon completion of renovation. Contractor shall employ crafts that originally performed the work.

End of Section 02 41 19

SECTION 23 05 00 MECHANICAL GENERAL PROVISIONS

1.0 GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to furnish same as well as furnish and install material and equipment usually furnished with such systems or required to complete the installation.

1.3 CODES, FEES, PERMITS, STANDARDS AND INSPECTIONS:

A. All work performed under these Specifications shall be in strict accordance with all applicable City, County, State and National Codes, Specifications and Ordinances, and in accordance with all Utility Company regulations.

B. Refer to Conditions of the Contract for payment of fees and permits.

C. All materials and workmanship shall comply with all applicable state and national codes, specifications, and specified industry standards.

D. The drawings and these specifications are intended to comply with all the above mentioned rules and regulations, however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation and, unless an interpretation is offered in writing by the Architect/Engineer, the applicable rules and regulations shall be complied with as a part of the contract.

E. In case of difference between building codes, specifications, state laws, industry standards and the Contract Documents, the most stringent shall govern.

1.4 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, crawl spaces, 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. Relocate: Remove and install in new location.

G. Contractor: Contractor responsible for all trades under the specifications covered by this Division.

H. Work: Labor and/or materials accruing in the provision of a system as defined by the drawings and these specifications.

I. Store: Provide an environmentally controlled space to protect the stored equipment from damage prior to installation.

J. Remove: De-energize, disconnect, and de-commission the designated equipment as related to the trades required to take the equipment out of service. This shall include transporting the equipment to an off-site location as required by authorities having jurisdiction and regulatory agencies, unless directed otherwise by the Architect/Engineer.

K. The following are industry abbreviations for plastic materials:

1) ABS: Acrylonitrile-butadiene-styrene plastic.

2) CPVC: Chlorinated polyvinyl chloride plastic.

3) NP: Nylon plastic.

4) PE: Polyethylene plastic.

5) PVC: Polyvinyl chloride plastic.

L. The following are industry abbreviations for rubber materials:

1) CR: Chlorosulfonated polyethylene synthetic rubber.

2) PDM: Ethylene propylene diene terpolymer rubber.

1.5 SUBMITTALS:

A. Product Data: For all equipment, piping and duct materials, insulation, valves, dampers, fittings, supports, identification materials, and other products to be purchased and installed.

B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

C. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relation with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1) Planned piping layout, including valve and specialty locations and valve-stem movement.

2) Clearances for installing and maintaining insulation.

3) Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.

4) Equipment and accessory service connections and support details.

5) Exterior wall and foundation penetrations.

6) Fire-rated wall and floor penetrations.

7) Sizes and location of required concrete pads and bases.

8) Scheduling, sequencing, movement, and positioning of large equipment into building during construction.

9) Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

10) Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

1.6 QUALITY ASSURANCE:

A. Comply with ASME Standards for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment installed shall have local representation; local factory authorized service, and a local stock of repair parts, within 100 miles of the Project site.

C. Comply with requirements of authorities having jurisdiction.

D. All equipment and materials shall be new and of the best quality.

E. All work shall be performed in the best and most workmanlike manner by mechanics skilled in their respective trades and properly licensed.

F. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases.

1.7 INSPECTION OF BUILDING SITE:

A. Contractor shall visit the site, verifying all existing items indicated on plans and/or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil, conditions, and local requirements. The submission of bids shall be deemed evidence of each visit. All Proposals shall take these existing conditions into consideration, and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.

B. Any asbestos that has been previously identified at the site will be clearly identified. If the contractor encounters any suspect asbestos containing material, the contractor shall stop work and immediately contact the Owner and Architect/Engineer.

1.8 SEQUENCING AND SCHEDULING:

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical 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. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.9 COORDINATION:

A. Contractor shall be responsible for detailing, coordinating and fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to provide proper grading of lines, to avoid all obstructions and to conform to the details of the installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated satisfactory operating installation, furnishing all necessary pilot lines and control lines whether indicated on the drawings or not. At no additional cost to the Owner, make all changes or additions to materials and/or equipment necessary to accommodate structural and architectural conditions.

B. The mechanical plans do not give exact details as to hanging methods of pipes, ducts, materials, etc. Contractor shall refer to the Architectural and Structural Drawings (if available) for exact details but without exception all hangers or channels installed under this division of these specifications and spanning between framing members shall be secured to the building structure.

C. The drawings do not give exact details as to elevations of pipe lines nor do they show exact locations of pipe to scale. Piping elevations shall be handled by giving precedence to pipes which require a stated grade for proper operation. Sewer piping shall take precedence over water pipes in determination of elevations. In all cases, pipes requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Before installation of piping systems, the Contractor shall refer to the Construction as it is then in progress and determine the exact required locations of these systems in conjunction with advice from the representative of the Architect/Engineer and/or Owner. Devices necessary for installation and support of pipes, and equipment (such as sleeves, inserts, etc.) shall be located and installed as the construction progresses in order to allow completion of each phase of the work in the proper sequence. Drawings showing the extent and arrangement of the work of a particular trade shall be used together with drawings showing extent and arrangement of work of other trades to insure that the Contractor in laying out and installing his work shall do so in a manner such that the work of the several trades may progress in the most direct, workmanlike harmonious manner.

D. Contractor shall be responsible for the proper location and size of slots, holes or openings in the building structure, and for the correct location of pipe sleeves. The drawings indicate the extent and general arrangement of the various systems, but if any departures from these drawings are deemed necessary by the Contractor, descriptions of

these departures and a statement of the reasons therefore shall be submitted to the Architect/Engineer as soon as practicable.

E. In general, piping and ductwork in finished areas of the building shall be installed and concealed in chases, furrings, and above suspended ceilings, unless noted and directed otherwise. Should any conditions arise which would cause any piping or ductwork to be exposed in finished areas, it shall be immediately called to the Architect/Engineer's attention and correction of the discrepancy shall be made in accordance with the Architect/Engineer's decision. In unfinished spaces such as equipment rooms, all pipe and ductwork shall be installed as high as possible and shall be installed to a continuous grade and shall be square to the building and securely supported. Piping shall be grouped wherever it is feasible to do so.

F. Equipment shall be installed in such a manner to make oiling devices and parts (such as filters, drives, bearings, etc.) requiring service and maintenance readily accessible.

G. All pipe, duct, etc., shall be cut accurately to measurements established at the building and shall be installed without springing or forcing. All ducts and pipes exposed in machinery and equipment rooms shall be installed parallel to the building planes, except that the lines shall be sloped to obtain the proper pitch. Piping and ducts above furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed during construction until the systems are completed with final connection.

H. The construction details of the building are illustrated on the Architectural and Structural Drawings. For new construction, place all inserts to accommodate the ultimate installation of pipe hangers in the forms before concrete is poured and set sleeves in forms before construction. For existing construction, all required inserts shall be "drilled-in" and all openings required through concrete or masonry shall be "saw-cut" or "core drilled" with tools specifically designed for this purpose.

I. The mechanical plans do not give exact details as to elevations of lines, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other location details. Carefully lay out work at the site to conform to the Architectural and Structural conditions, to provide proper grading of lines, to avoid all obstructions, to conform to the details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated satisfactory operation installation.

J. The Mechanical Drawings do not give exact locations of outlets, fixtures, equipment items, etc. The exact location of each item shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building and in cooperation with other trades. Minor relocations necessitated by the conditions at the site or directed by the Owner shall be made without additional cost to the Owner.

K. Contractor shall supply and set in place waterproof flashings where pipes and ducts pass through roofs.

L. No asbestos will be installed at this site.

M. Locations and elevations of the various utilities, included within the scope of the work, have been obtained from utility maps and/or other substantially reliable sources and are offered separate from the contract documents as a general guide only, without guarantee as to accuracy. The Contractor shall examine the site and shall verify to his own satisfaction the size, location and elevations of all utilities and shall adequately inform himself of their relation with the work before entering into a contract.

1.10 EQUIPMENT CONNECTIONS:

A. It is the intent of the Contract Documents that all systems and equipment being furnished under the air conditioning and/or plumbing sections of these specifications shall be provided with all necessary utility connections completed to allow safe and proper operation of said systems. Where it is necessary to make final connections to items of equipment specified under other sections of these Specifications, all such work shall be performed in a neat and workmanlike manner and all materials shall be of quality and finish normally used for such installation.

1.11 SPACE AND EQUIPMENT ARRANGEMENT:

A. Size of equipment shown by the drawings is based on the dimensions of a particular manufacturer. Where other manufacturers are acceptable, it is the responsibility of the contractor to determine if the equipment he proposes to furnish will fit the space.

B. Equipment shall be installed in a manner that will permit access to all surfaces requiring access. Proper clearances shall be maintained to meet all safety and operating requirements or codes and standards.

1.12 OPERATION PRIOR TO COMPLETION:

A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so providing that he properly supervises the operation. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner or until final acceptance by the Owner.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, and properly adjust the operation of the equipment before final acceptance by the Owner.

1.13 PROJECT RECORD DOCUMENTS AND RECORDS FOR OWNER:

A. Project record documentation and records for the Owner shall be as specified in Division 01, General Requirements Section.

B. In addition to the Division 01 of these specifications provide the following minimum items:

1) Operations & Maintenance Manuals: Include, as appropriate to each item sufficient information to provide for the Owner’s operation and maintenance of equipment furnished.

2) As-Builts: Include neatly marked set of reproducible drawings showing “As Installed” work.

3) Contacts: Include with each product, name, address, and telephone numbers, of installing contractor, factory and local service representative.

4) Instructions of Owner’s Personnel: Prior to final inspection and acceptance, fully instruct the Owner’s designated operating and maintenance personnel in the operating and performance of the equipment furnished.

5) Warranties: Include warranty information properly executed by respective manufacturers, suppliers, or sub-contractors for the equipment and system furnished.

2.0 PRODUCTS

2.1 CONSTRUCTION MATERIALS:

A. All materials shall be new and shall conform to the requirements of applicable Codes and/or the Standards Organizations regulating those products.

2.2 FLAME SPREAD PROPERTIES OF MATERIALS:

A. All materials and adhesives used for air conditioning filters, acoustical lining and insulation, etc. shall conform to NFPA and UL life and safety and flame spread properties of materials. The composite classifications shall not exceed 25 for a flame spread rating and 50 for a smoke developed rating for these classifications as listed for the basic materials, the finishes, adhesives, etc., specified for each system and shall be such when completely assembled.

2.3 STANDARD PRODUCTS:

A. All materials and equipment shall be standard catalog products of domestic manufacturers regularly engaged in the manufacture of products conforming to these specifications. Materials and equipment shall have been in satisfactory use at least two years prior to bid opening. Where custom or special items are required, these shall be fully described by drawings and/or material list which detail the item proposed for use on this project.

B. In order to insure a uniform system providing ease of maintenance, operation, and repair, similar types of equipment shall be provided by a single manufacturer.

2.4 ACCEPTABLE MANUFACTURERS:

A. Specifications and drawings are intended to indicate a minimum standard of quality for materials and equipment which is established by the listing of manufacturers' names and catalog numbers and/or the defining of the technical characteristics in detail or by referenced standards. Materials and equipment that do not comply with these standards of quality will NOT be considered.

B. Contractor shall be responsible to identify any deviation of the submittal from the specified manufacturer, product, equipment or material. Approval by the Engineer shall NOT be considered as acceptance of the deviation unless specifically identified and acknowledged by the Engineer during the submittal process.

C. Where only one manufacturer's name is listed in the equipment specification, other manufacturers of similar characteristics and of equal or better performance capacities may be considered for "or equal" approval by the Engineer. Where more than one manufacturer is listed in the equipment specification, only those named manufacturers will be considered.

D. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended, within the guarantee or warranty period, this material or equipment shall be replaced with the material or equipment specified at no cost to the Owner.

2.5 MANUFACTURERS INSTRUCTIONS:

A. The Contractor is fully responsible for furnishing the proper equipment and/or material and for seeing that it is installed as intended by the manufacturer's written instructions. If needed for proper installation, operation, or start up, the Contractor shall request advice

and assistance from a representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning all materials and equipment. The Contractor shall promptly notify the Architect/Engineer in writing of any conflict between the requirements of the contract documents and the manufacturer's directions and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or instructions from the Architect/Engineer, he shall bear all costs arising in connection with correcting the deficiencies to the satisfaction of the Engineer and Owner.

2.6 DELIVERY, STORAGE, AND HANDLING:

A. The Contractor shall not deliver any equipment to the job site until the equipment is ready to be installed or until there is suitable space provided to properly protect equipment from weather, humidity, dust, and physical damage.

B. During construction, protect all materials and equipment from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps, ventilation or other suitable means. Apply protection immediately upon receiving the products and maintain continuously.

C. Keep products clean by elevating above ground or floor and by using suitable coverings.

D. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

E. Protect factory finish from damage during construction operations and until acceptance of the project. Restore any finishes that become marred or damaged to the satisfaction of the Owner and Architect/Engineer.

F. All internally lined ductwork shall be capped and stored within a weather tight location with a maximum relative humidity of 65% until installation.

G. All insulation shall be stored within a weather tight location with a maximum relative humidity of 65% until installation.

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

I. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

J. Protect flanges, fittings, and piping specialties from moisture and dirt.

K. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

3.0 EXECUTION

3.1 INSTALLATION:

A. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work. The Contractor is responsible to coordinate with other trades in order to effect timely and accurate placing of work and to bring together, in proper and correct

sequence, the work of such trades. Provide coordination drawings showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

B. All equipment shall be installed level and plumb. Sheet metal enclosures shall be separated from walls a minimum 1/2-inch by installing corrosion-resistant spacers or metal framing. Provide corrosion-resistant bolts, nuts and washers to anchor equipment.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnection, with minimum interference to other installations. Extend grease fittings to accessible locations. Manufacturer's required access shall be provided in addition to any code required clearances.

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

E. Permanently seal outdoor equipment at the base using concrete grout. Seal or screen openings into equipment to prevent entrance of animals, birds and insects. Use galvanized steel or copper mesh with openings not larger than 1/16-inch for screened openings. Seal small cracks and openings from the inside with a silicone sealing compound.

3.2 CONCRETE BASES:

A. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

B. Construct concrete bases of dimensions indicated, but not less than 3 inches larger in both directions than supported unit.

C. 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.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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

G. Use 3000-psi, 28-day compressive-strength concrete and steel reinforcement.

3.3 SLEEVES AND ESCUTCHEONS:

A. The Subcontractor shall be responsible for the timely placing of sleeves as detailed on the Drawings and the Coordination Drawings for all piping and ductwork passing through walls and partitions, beams, floors and roofs as noted below, while the same are under construction:

1) All concrete or masonry construction.

2) Wall construction where the penetration must be sealed air tight. Patches for penetrations through walls for Work installed prior to finish application shall be provided by others.

3) Fire rated wall construction.

4) All penetrations when piping is supported on vibration isolators.

5) All penetrations when piping is insulated.

6) Where indicated on the Drawings.

B. A pipe sleeve shall be at least one size larger than the size of pipe, including the insulation where applicable, it serves except where “Link Seal” casing seals are used in sleeves through walls below grade. Sleeves shall be sized such that the annular space between the sleeve and the pipe (or the pipe insulation if the pipe is insulated) will not be less than 1/2". All pipes passing through concrete or masonry walls above grade shall be at least 18 gauge galvanized steel sleeves. Sleeves shall be set flush with finished wall. All sleeves in floors shall extend a minimum of 2” above the finished floor, except sleeves for sleeves in stairwells and for water closet waste piping within toilet chases. Sleeves installed in fire rated construction shall be of suitable length and diameter to accommodate the firesafing system used. Sleeves set in concrete floor construction, which do not support piping shall be at least 16 gauge galvanized steel. Sleeves set in concrete floor construction supporting riser piping shall be standard weight steel pipe. Sleeves supporting riser piping larger than 6” shall have three (3) 6” long reinforcing rods welded radially at 120º spacing to the sleeve and shall be installed with the rods embedded in the concrete slab. Where the pipe passes through a sleeve, no point of the pipe or its insulation shall touch the sleeve and the pipe shall be centered in the sleeve.

C. Seal all pipe penetrations in fire rated construction with factory built devices or with manufactured fill, void or cavity materials “Classified” by Underwriters Laboratories, Inc. for use as a Through Penetration Firestop. All firestop devices and systems shall be approved for such use by the authorities having jurisdiction. The firestop system used shall maintain the fire resistance rating of the building component that is penetrated. Firestop systems and devices shall comply with ASTME 814 (UL 1479) for all types of penetration being sealed. Submittal data for firestop systems shall include the applicable UL System Numbers. Excessive shrinkage of the firestop materials, which would permit the transmission of smoke or water prior to exposure to a fire condition, is unacceptable. Where a mastic coating is used to seal the surface of the firestop, the mastic shall be non-hardening. The firestop system used shall accommodate expansion and contraction of the floating mechanical piping systems without damaging the firestop or reducing its effectiveness as a smoke barrier or water seal. See Section 23 05 41 titled “Vibration Isolation”. The firestop manufacturer’s representative shall instruct the Subcontractor’s representatives in the proper installation procedures so that the penetrations on the Project will be installed in accordance with the UL listing and the manufacturer’s recommendations. If it complies with these Specifications, firestop sealing component/system as manufactured by one of the following manufacturers will be acceptable:

1) Tremco Fire Resistive Joint System using Dymeric sealant and Cerablanket-FS mineral filler.

2) Specified Technologies, Inc. SpecSeal Systems.

3) 3M Fire Barrier Penetration Sealing Systems.

4) GE Pensil Firestop Sealant by General Electric.

5) International Protective Coatings Corp. Flame Safe Systems.

6) Thermal Ceramics Fire Master Firestop Fire Protection Systems.

7) Hilti FS-601 Systems.

D. Sleeves penetrating walls below grade shall be standard weight black steel pipe with ¼" thick steel plate waterseal secured to the pipe with continuous fillet weld. The waterseal plate shall be located in the middle of the wall and shall be 2" wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. Seal off annular opening between pipe and sleeve with "Link Seal" type casing as manufactured by PSI-Thunderline Corporation or Innerlynx. The pipe sleeve shall be sized to accommodate the Thunderline casing seal. Casing seals shall be Series 300 for pipe size ¾" through 4" and Series 400 for pipe sizes 5" through 24" and Series 500 for 30" and larger.

E. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no additional expense to the Owner. The Subcontractor shall undertake no cutting or patching without first securing the Architect's written approval.

F. All unused sleeves shall be sealed with firestop devices and systems to maintain the fire rating of the construction penetrated.

G. Escutcheons, except as specifically noted or specified, shall be installed on all pipes passing exposed through the floors, walls, or ceilings. Escutcheons shall be equal to the Crane No. 10, chrome plated sectional floor and ceiling plates, and shall fit snugly and neatly around pipe or pipe insulation or insulated lines. Solid chrome plates with set screws shall be used if sectional plates do not fit properly or stay in place.

H. Where ducts, pipes, etc., are routed vertically through shafts, the Subcontractor shall furnish and install all necessary miscellaneous structural members to support the loads imposed by the risers.

I. The Contractor shall submit Shop Drawings of the riser support system inside vertical shafts to the Project Structural Engineer for approval, including details of how the riser support structure is to be attached to the building structure.

J. The Subcontractor shall provide all miscellaneous support members required to support horizontal pipe, ductwork and equipment.

K. Miscellaneous structural support members installed in central plants, mechanical rooms and where exposed to public view shall be galvanized.

3.4 FLASHINGS:

A. Flash around all pipes passing through the roof in connection with this contract, with sheet lead weighing not less than 4 lbs. to the square foot built a minimum of 10" into the roofing, in all directions form the outside of the pipe running up the pipe a minimum of 10" and more where vent terminals must be higher to conform to the requirements of the Plumbing Code, and then turned over one inch (1") into the pipe cavity. All seams and

joints shall be completely soldered closed and the entire flashing shall be completely waterproof.

B. Flash around all other roof penetrations in accordance with the roofing system manufacturer's recommendations

3.5 ACCESS DOORS/PANELS:

A. Each Contractor shall furnish to the General Contractor for installation by the General Contractor a steel access door/panel for each of his valves, group of valves, or other controlling mechanism which would otherwise be concealed in the building construction with no access. Minimum size shall be 12" x 18".

B. Access doors shall be similar and equal to "Milcor" steel access doors and shall be Type "DWI" or "KII" for gyp board or for lathe and plaster walls, and ceilings, as the condition requires. Each door shall be furnished with a flush screw-drive operated lock and shall be furnished with one prime coat of gray rust inhibitive paint. Each access door shall have U.L. rating to match area in which it is installed.

C. All access doors in toilet rooms shall be flush mounted made of brushed finish stainless steel similar or equal to Milcor.

3.6 SAFETY GUARDS:

A. The Mechanical Contractor shall furnish and install all safety guards required in order to obtain certificates of inspection from all authorities having jurisdiction. All belt driven equipment, projecting shafts and other rotating parts shall be enclosed or adequately guarded.

3.7 CUTTING AND PATCHING:

A. When it becomes necessary to cut through any wall, floor, or ceiling to install any work under the Contract, or to repair any defects that may appear up to the expiration of the guarantee period, such cutting shall be done by the Contractor. The Contractor will not be permitted to cut or modify any structural members without the written permission of the Owner and Engineer.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades caused by cutting or by the failure of any part of the work installed under this Contract, shall be performed by the appropriate trade and shall be paid for by the Contractor. Restore the surface to match the adjacent surfaces to the satisfaction of the Owner, Architect and Engineer. Obtain approval of restoration prior to submitting Substantial Completion Pay Application. Failure to do so may result in the contracting of a third party to perform the work. This Contractor will be held responsible for complete payment of third party Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements. All openings shall be waterproofed upon completion of the work as specified by the Architect/Engineer. Any openings through fire rated walls or floors shall be sealed to maintain the minimum fire rating of wall or floor penetrated.

3.8 EXCAVATION AND BACK-FILLING:

A. Provide necessary excavating and back-filling for the installation of work specified in this Division. Architectural Site Work Division specifications to be adhered to in conjunction with these specifications. Trenches for underground piping and conduits shall be installed with a minimum of 24" cover unless otherwise indicated. Bell holes to be provided as necessary to insure uniform bearings. Care shall be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where rock or hard objects are encountered, they shall be excavated to a grade six inches (6") below as specified. After the pipe has been installed, tested, and approved, the trenches shall be back-filled with eight inches (8") of sand, above and below, or gravel free of rocks, metal, or other foreign materials, and to grade with approved material, well compacted in place. Do not proceed with back-fill operations until piping has been inspected by the Owner's Representative. Do not perform back-filling operations, except in the presence of the Owner's Representative. This Contractor shall give the Owner's Representative 48 hours notice for such observation. All piping outside the building shall be installed below the frost line. Where streets, sidewalks, etc., are disturbed, cut or damaged by this work, the expense of repairing same in a manner approved by the Owner's Representative shall be part of this contract.

B. Contractor shall bear sole responsibility for design and execution of acceptable trenching and shoring procedures, in accordance with State of Texas HB 662 and HB 665. On trench excavations in excess of five feet in depth, Contractor shall pay a qualified engineer to prepare detailed plans and specifications directing Contractor in Safe execution of trenching and shoring. It is understood that trench safety systems constitute a means and method of construction for which the Engineer and Owner are responsible. Accordingly, such documents when prepared shall be separately issued by Contractor's Consultant, independent of project Contract Documents.

C. Trenches shall be a minimum of 6" wide and not less than 4" wider than the outside diameter of the pipe. Piping and conduit installed in the same trench shall have a minimum of 4" of sand between them. Sewer and water pipe shall not be installed in the same trench unless the water pipe can be installed a minimum of 18" above the sewer pipe.

D. Trenches to provide clearance (24" minimum) under suspended pipe, conduit and ductwork under the building must be excavated by the Mechanical and Electrical Contractors if this clearance is not provided by the Owners Representative or General Contractor. Mechanical and Electrical Contractors shall be responsible for necessary excavation to obtain such clearance, and if such clearance is not found to exist at the completion of the project, the Mechanical and Electrical Contractors shall excavate as required to meet this specification.

3.9 PAINTING:

A. All apparatus furnished under this contract to be painted shall be thoroughly cleaned, rust scraped off, all oil and grease scraped, and washed off before any paint is applied.

B. Finished painting coats shall not be applied until this and other Contractors have completed their work in the area to a point that the finish painting will not be soiled or damaged. Drop cloths shall be spread where necessary to prevent oil or paint from defacing adjacent finishes.

C. All pipe covered with canvas glass cloth shall be sized by the insulator for painting and then painted by the Contractor with two coats of enamel paint. All other un-insulated piping, hangers, ducts, supports, etc., shall be primed and painted with two coats of two part polyurethane enamel.

D. Items with factory applied enamel painting shall be protected during installation and other construction work. Damaged factory applied finishes shall be repainted by the Installing Contractor. Scratches to factory applied finish shall be sanded smooth before repainting.

E. All mechanical equipment to be painted shall be cleaned, smoothed, primed with one coat of primer, and painted with two coats of two part polyurethane enamel. Care shall be taken in painting equipment not to cover, deface, or render illegible in any way, the name plates on equipment or impair the operation or foul any moving parts of the equipment.

F. All items installed by this Contractor which are exposed to view, including in mechanical rooms, shall be painted by this Contractor (Mechanical). All pipe hangers, rods, supports, and inserts in furring or vertical pipe chases as in crawl spaces, shall be painted by this Contractor with two coats of asphalt emulsion. Concrete bases shall be painted with grey two part polyurethane enamel.

G. Refer to Architectural Specifications for quality of paint materials, color coding requirements, and other specific requirements.

3.10 HOISTING, SCAFFOLDING, AND TRANSPORTATION:

A. The Contractor shall provide his own hoisting, scaffolding and ladders as required to set his materials and equipment in place.

B. The Contractor shall provide all necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job.

3.11 CLEANING:

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. Debris shall be removed, not only from the building, but also from the site and from any public area adjacent to the site.

B. At completion of the project, the Contractor shall remove all of his tools, scaffolding, and surplus materials.

3.12 WARRANTIES:

A. Comply with the requirements of Division 01.

3.13 GUARANTEE:

A. The Contractor shall guarantee all materials and workmanship for a period of twelve (12) months after the final acceptance of work.

End of Section 23 05 00

SECTION 23 05 19 METERS, GAUGES, AND TEST PLUGS

1.0 GENERAL

1.1 SYSTEM DESCRIPTION:

A. Furnish and install all meters, gauges, and test plugs of every kind required, specified, or shown on the drawings for the installation of the Mechanical work.

1.2 QUALITY ASSURANCE:

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a workmanlike manner by experienced installers.

1.3 SUBMITTALS:

A. Product Data: Submit complete manufacturer's descriptive literature and installation instructions. Include scale range, ratings, and calibrated performance curves for each meter and gauge.

B. Product Certificates: Signed by manufacturers of meters and gauges certifying accuracies under specified operating conditions and compliance with specified requirements.

C. Maintenance Data: For meters and gauges to include in maintenance manuals.

1.4 PRODUCT HANDLING:

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction will be rejected.

B. Storage and protection of materials shall be as specified in Section 23 05 00, Mechanical General Provisions.

2.0 PRODUCTS

2.1 MANUFACTURERS:

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

1) Thermometers and Pressure Gauges:

a. H. O. Trerice Co.

b. Weiss Instruments, Inc.

c. Weksler

2) Test Plugs:

a. Flow Design, Inc.

b. H. O. Trerice Co.

c. Peterson Equipment Co., Inc.

d. Watts Industries, Inc.; Water Products Div.

2.2 THERMOMETERS, GENERAL:

A. Scale Range: Temperature ranges for services listed are as follows:

1) Domestic Hot Water: 30 to 240 degrees F, with 2-degrees scale divisions (0 to 115 degrees C, with 1-degrees scale divisions).

2) Domestic Cold Water: 0 to 100 degrees F, with 2-degrees scale divisions (minus 18 to plus 38 degrees C, with 1-degrees scale divisions).

3) Hot Water: 30 to 300 degrees F, with 2-degree scale divisions (0 to 150 degrees C, with 1-degree scale divisions).

4) Condenser Water: 0 to 160 degrees F, with 2-degree scale divisions (minus 18 to plus 70 degrees C, with 1-degree scale divisions).

5) Chilled Water: 0 to 100 degrees F, with 2-degree scale divisions (minus 18 to plus 38 degrees C, with 1-degree scale divisions).

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS:

A. Description: Comply with Standards ASTM.

B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches (230 mm) long.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red or blue reading, organic-liquid filled with magnifying lens.

E. Scale: Satin-faced non-reflective aluminum with permanently etched markings.

F. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.4 DIRECT-MOUNTING, FILLED-SYSTEM DIAL THERMOMETERS:

A. Description: Vapor-actuated, universal-angle dial type.

B. Case: Drawn steel or cast aluminum, with 4-1/2-inch- (115-mm-) diameter, glass lens.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Thermal Bulb: Copper with phosphor-bronze bourdon pressure tube.

E. Movement: Brass, precision geared.

F. Scale: Progressive, satin-faced non-reflective aluminum with permanently etched markings.

G. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.5 SEPARABLE SOCKETS:

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1) Material: Brass, for use in copper piping.

2) Material: Stainless steel, for use in steel piping.

3) Extension-Neck Length: Nominal length of 2 inches (50 mm), but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.

4) Insertion Length: To extend to one-third of diameter of pipe.

5) Heat-Transfer Fluid: Oil or graphite.

2.5 THERMOMETER WELLS:

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.

1) Material: Brass, for use in copper piping.

2) Material: Stainless steel, for use in steel piping.

3) Extension-Neck Length: Nominal thickness of 2 inches (50 mm), but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.

4) Insertion Length: To extend to one-third of diameter of pipe.

5) Cap: Threaded, with chain permanently fastened to socket.

6) Heat-Transfer Fluid: Oil or graphite.

2.6 PRESSURE GAUGES:

A. Description: Comply with ASME Standards, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- (115-mm-) diameter, glass lens.

C. Connector: Brass, NPS ¼" (DN8).

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.

F. Range: Comply with the following:

1) Vacuum: 30 inches Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).

2) Fluids under Pressure: Two times the operating pressure.

2.7 PRESSURE-GAUGE FITTINGS:

A. Valves: NPS 1/4 (DN8) brass or stainless-steel ball valves.

B. Syphons: NPS 1/4 (DN8) coil of brass tubing with threaded ends.

C. Snubbers: NPS 1/4 (DN8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS:

A. Description: Nickel-plated, brass-body test plug in NPS ¼" (DN8) fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig (3450 kPa) minimum.

D. Core Inserts: Two self-sealing valves, suitable for inserting 1/8-inch (3-mm) OD probe from dial-type thermometer or pressure gauge.

E. Core Material for Air and Water: Minus 30 to plus 275 degrees F (Minus 35 to plus 136 degrees C), ethylene-propylene-diene terpolymer rubber.

F. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

3.0 EXECUTION

3.1 GENERAL INSTALLATION:

A. Install meters, gauges, and accessories according to manufacturer's written instructions for applications where used.

B. Install all meters, gauges, test plugs and other piping devices to facilitate visibility and access for service, maintenance, and repair or replacement of components. Connect devices for ease of disconnection, with minimum interference to other installations.

C. Provide extensions for all test plugs, thermometers and gauges installed on insulated piping. Extension length shall be equivalent to the insulation thickness to that that test plug heads, thermometer and gauge sockets, and valves remain accessible after piping is fully insulated without requiring insulation removal.

3.2 THERMOMETER INSTALLATION:

A. Install thermometers and adjust vertical and tilted positions.

B. Install in the following locations:

1) Inlet and outlet of each hydronic zone.

2) Inlet and outlet of each hydronic boiler and chiller.

3) Inlet and outlet of each hydronic coil in air-handling units.

C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1) Install with socket extending to one-third of diameter of pipe.

2) Fill sockets with oil or graphite and secure caps.

D. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.

1) Install with stem extending to one-third of diameter of pipe.

2) Fill wells with oil or graphite and secure caps.

3.3 PRESSURE-GAUGE INSTALLATION:

A. Install pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position.

B. Install dry-type pressure gauges in the following locations:

1) Discharge of each pressure-reducing valve.

2) Building water-service entrance.

3) Chilled-water and condenser-water inlets and outlets of chillers.

4) Hot-Water inlet and outlet of each boiler.

C. Install liquid-filled-type pressure gauges at suction and discharge of each pump.

D. Install pressure-gauge ball valve and snubber in piping to pressure gauges.

3.4 CONNECTIONS:

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Make electrical connections to power supply and electrically operated meters and devices.

C. Ground electrically operated meters.

1) Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Install electrical connections for power and devices.

E. Electrical power, wiring, and connections are specified in Division 26 Sections.

3.5 ADJUSTING AND CLEANING:

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gauges to proper angle for best visibility.

C. Clean windows of meters and gauges and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

End of Section 23 05 19

Section 23 05 23 GENERAL-DUTY VALVES

1.0 GENERAL

1.1 SUMMARY:

A. This Section includes general duty valves common to several HVAC water piping systems, 200°F and below.

B. Related Sections:

1) Special purpose valves are specified in Division 23 Section “Hydronic Piping Specialties”.

2) Valve tags and charts are specified in Division 23 Section “Mechanical Identification”.

C. Valves shall be installed to control the flow of gas or water to each of the various systems, to segregate individual items of equipment and parts of fluid circulating or supply systems, and to permit draining of systems or portions thereof, to blow-off strainers, etc., as directed by the drawings and specifications.

1.2 QUALITY ASSURANCE:

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a workmanlike manner by experienced installers.

1.3 SUBMITTALS:

A. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions, and required clearances, and installation instructions. Include list indicating valve and its application.

B. Maintenance data for valves to include in the operation and maintenance manual. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Prepare valves for shipping as follows:

1) Protect internal parts against rust and corrosion.

2) Protect threads, flange faces, grooves, and weld ends.

3) Set globe valves closed to prevent rattling.

4) Set ball and plug valves open to minimize exposure of functional surfaces.

5) Set butterfly valves closed or slightly open.

6) Block check valves in either closed or open position.

B. Use the following precautions during storage:

1) Take special precautions to protect valve internals from construction dirt and debris. If valves are stored on site, cover valve openings until just prior to installation but in no case shall valves be unprotected for more than 48 hours.

2) Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

2.0 PRODUCTS

2.1 MANUFACTURERS:

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

1) General-Duty Valves:

a. Bray International.

b. Crane Company.

c. Nibco, Inc.

d. Victaulic Company of America.

2) Triple-Duty Combination Valves:

a. Armstrong Pumps (S.A. Armstrong, Ltd.)

b. Aurora Pumps (Pentair, Ltd.)

c. Bell & Gossett (Xylem, Inc.)

d. Taco, Inc.

B. All valves of any one type shall be of the same make throughout and insofar as practicable all valves in a given category shall be of the same manufacture.

BASIC, COMMON FEATURES:

A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.

1) Nonrising stem valves may be used only where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Use specified operators and handwheels, except provide the following special operator features:

1) Handwheels: For valves other than quarter turn.

2) Lever Handles: For quarter-turn valves 6 inches (DN150) and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.

3) Chain-Wheel Operators: For valves 4 inches (DN100) and larger, installed 96 inches (2400 mm) or higher above finished floor elevation.

4) Gear-Drive Operators: For quarter-turn valves 8 inches (DN200) and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

2.3 BALL VALVES:

A. Ball Valves, 4 Inches (DN100) and Smaller: Class 150, 600-psi CWP, bronze body and bonnet, 2-piece construction; chrome-plated brass ball, full port for 1/2-inch (DN15) valves and smaller and full port for 3/4-inch (DN20) valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

1) Operator: Vinyl-covered steel lever handle.

2) Operator: Lever operators with lock.

3) Stem Extension: For valves installed in insulated piping.

4) Memory Stop: For operator handles.

2.4 GLOBE VALVES:

A. Globe Valves, 2 Inches and Smaller: Class 125, 200-psi CWP, or Class 150, 300-psi CWP; cast-bronze body and screwed bonnet, rubber, bronze, or teflon disc, silicon bronze-alloy stem, teflon-impregnated packing with bronze nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

B. Globe Valves, 2-1/2 Inches and Larger: Class 125, 200-psi CWP, cast-iron body and bolted bonnet with bronze fittings, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

2.5 BUTTERFLY VALVES:

A. Butterfly Valves: 200-psi CWP, 150-psi maximum pressure differential, cast-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals, lug, or grooved style:

1) Disc Type: Aluminum bronze.

2) Operator for Sizes 2 Inches (DN50) to 6 Inches (DN150): Lever handle with latch lock.

3) Operator for Sizes 8 Inches (DN200) to 24 Inches (DN600): Gear operator with position indicator.

4) Operator for Sizes 8 Inches (DN200) and Larger, 96 Inches or Higher above Floor: Chain-wheel operator.

2.6 CHECK VALVES:

A. Swing Check Valves, 2 Inches and Smaller: Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections.

B. Swing Check Valves, 2-1/2 Inches and Larger: Class 125, 200-psi CWP, cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

C. Lift Check Valves, 2-1/2 Inches and Larger: Class 125, 200-psi CWP, cast-iron body, bronze disc, Buna-N seat, stainless steel spring.

2.7 TRIPLE-DUTY COMBINATION VALVES:

A. Triple-duty pump discharge valves shall have a non-slam check valve with spring-loaded disc and calibrated adjustment feature permitting regulation of pump discharge flow and shutoff.

B. Valve body: Cast iron or ductile iron valve body with flanged or grooved end connections, pressure rated for 175 psi, maximum operating temperature of 200°F.

C. Internal components: Bronze disc, stainless steel stem and spring.

3.0 EXECUTION

3.1 EXAMINATION:

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION:

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow isolation for servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Each valve for installation in a line to be insulated shall be provided with extension necks to allow sufficient clearance between the valve body and the operating handle such that valve operation shall not physically damage the insulation.

F. Install valves in horizontal piping with stem at or above the center of the pipe.

G. Install valves in a position to allow full stem movement.

H. For chain-wheel operators, extend chains to 60 inches above finished floor elevation.

I. Install check valves for proper direction of flow, aligned and leveled in accordance with the manufacturer's instructions.

3.3 SOLDERED CONNECTIONS:

A. Piping shall be cut square and to exact lengths, with ends de-burred, cleaned and prepared for solder.

B. Insert pipes fully into valve socket, making sure the end rests against the shoulder inside valve.

3.4 THREADED CONNECTIONS:

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

3.5 FLANGED CONNECTIONS:

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.6 VALVE END SELECTION:

A. Select valves with the following ends or types of pipe/tube connections:

1) Copper Pipe, Size 2 Inches and Smaller: Solder ends, except provide threaded ends for heating hot water service.

2) Steel Pipe, Size 2 Inches and Smaller: Threaded end.

3) Steel Pipe, Size 2-1/2 Inches and Larger: Grooved end or flanged.

3.7 VALVE APPLICATION:

A. General Application: Use ball and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Unless noted otherwise, ball valves should be used in piping 2" and smaller, and butterfly valves should be used in piping 2-1/2" and larger.

B. Typical Application Schedule:

Pipe Size	Pipe Material	Valve Type	Fitting Type
2 ½" and Larger	Steel	Butterfly	Flanged
2" and Smaller	Copper	Ball	Threaded/Soldered
2 ½" and Larger	Steel	Check	Flanged
2" and Smaller	Copper	Check	Threaded/Soldered

C. Install shutoff duty valves at each branch connection to supply mains when the branch supplies multiple pieces of equipment.

D. Install shutoff duty valves at each supply connection to each piece of equipment. Install throttling duty valves at each return connection from each piece of equipment.

E. Install check valves at each pump discharge and elsewhere as required to control flow direction.

3.8 ADJUSTING:

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

End of Section 23 05 23

SECTION 23 05 29 HANGERS AND SUPPORTS

1.0 GENERAL

1.1 SYSTEM DESCRIPTION:

A. Furnish and install all supporting structures and members required for pipes and equipment.

B. Support devices and members shall include vibration and noise isolating devices and assemblies specified in Division 23 Section “Vibration Isolation”.

1.2 QUALITY ASSURANCE:

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a workmanlike manner by experienced installers.

C. For field-fabricated supports and hangers: Design and calculations for each multiple pipe support and trapeze to be performed or reviewed by a qualified professional engineer.

1.3 SUBMITTALS:

A. Product Data: Submit complete manufacturer's descriptive literature and installation instructions.

B. Shop Drawings: Submit shop drawings for custom-fabricated supports in accordance with Section 23 05 00, Mechanical General Provisions.

C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.4 PRODUCT HANDLING:

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction will be rejected.

B. Storage and protection of materials shall be as specified in Section 23 05 00, Mechanical General Provisions.

2.0 PRODUCTS

2.1 MANUFACTURERS:

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

1) Pipe Hangers:

a. B-Line Systems, Inc.

b. Anvil International

c. PHD Manufacturing, Inc.

d. PHS Industries, Inc.

e. Piping Technology & Products, Inc.

2) Channel Support Systems:

a. B-Line Systems, Inc.

b. Anvil International

c. Unistrut Corp.

3) Thermal-Hanger Shield Inserts:

d. PHS Industries, Inc.

e. Pipe Shields, Inc.

f. Rilco Manufacturing Co., Inc.

4) Rooftop Pipe and Equipment Supports:

a. MIFAB, Inc.

b. MIRO Industries

c. PHP Systems/Design

2.2 MANUFACTURED UNITS:

A. Pipe Hangers, Supports, and 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: 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. Rooftop piping and equipment supports shall be constructed with galvanized steel components set on a UV- and impact-resistant plastic or recycled rubber base designed to support application-specific loads without damaging the roof surface. Supports shall not require roof penetrations unless noted otherwise on the drawings.

D. Thermal-Hanger Shield Inserts: 100-psi (690-kPa) minimum compressive-strength insulation, encased in sheet metal shield.

1) Material for Insulated Piping: ASTM, Type I cellular glass or water-repellent-treated, ASTM, Type I calcium silicate.

2) For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.

3) For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.

4) Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS:

A. Structural Steel: ASTM steel plates, shapes, and bars, black and galvanized. All exterior pipe support systems shall be zinc rich hot dip galvanized.

B. Grout: ASTM, 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.

2) Properties: Nonstaining, noncorrosive, and nongaseous.

3) Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

3.0 EXECUTION

3.1 SIZE AND SPACING:

A. Hanger rod sizes shall conform to the following schedule:

Pipe up to and including 2”	3/8” rods
Pipe 2 ½”, 3” and 3 ½”	1/2” rods
Pipe 4” and 5”	5/8” rods
Pipe 6”	3/4” rods

B. Unless otherwise shown on the Plans, all horizontal runs of ferrous piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to and including 1 ¼”	8 feet
Pipe 1 ½” and 2”	10 feet
Pipe 2 ½” and 3”	12 feet
Pipe 3 ½” and 4”	14 feet
Pipe 5” and 6”	16 feet

C. Unless shown otherwise on the Plans, all horizontal runs of copper piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to ¾” in size	5 feet
Pipe 1” and 1 ¼”	8 feet
Pipe 1 ½” and larger	10 feet

D. There shall be a hanger within two feet (2') of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps. Vertical pipes within a space shall have not less than two (2) supports.

3.2 HANGER AND SUPPORT APPLICATIONS:

A. Pipe hangers shall be of a type suitable for each use. Perforated straps shall not be used in any work. For ferrous pipes up to and including four inches (4") in size malleable iron, adjustable, split ring, swivel hanger. For plumbing piping larger than four inches (4"), use steel clevis hanger. Where several pipes are parallel at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on rollers. For copper pipes up to and including three inches (3") in size, use malleable iron, copper plated hangers. For copper pipes larger than three inches (3"), use copper-plated clevis hanger.

B. 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: For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).

2) Yoke-Type Pipe Clamps: For suspension of 120 to 450 degrees F (49 to 232 degrees C) pipes, NPS 4 to NPS 16 (DN100 to DN400), requiring up to 4 inches (100 mm) of insulation.

3) Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps: For suspension of pipes, NPS 3/4 to NPS 24 (DN20 to DN600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.

4) Steel Pipe Clamps: For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN15 to DN600), if little or no insulation is required.

5) Pipe Hangers: For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), to allow off-center closure for hanger installation before pipe erection.

6) Adjustable Swivel Split- or Solid-Ring Hangers: For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8 (DN20 to DN200).

7) Adjustable Steel Band Hangers: For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).

8) Adjustable Band Hangers: For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).

9) Adjustable Swivel-Ring Band Hangers: For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).

10) Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers: For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).

11) Extension Hinged or Two-Bolt Split Pipe Clamps: For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3 (DN10 to DN80).

12) U-Bolts: For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).

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

14) Pipe Saddle Supports: For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast-iron floor flange.

15) Pipe Stanchion Saddles: For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16) Adjustable Pipe Saddle Supports: For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17) Single Pipe Rolls: For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN750), from two rods if longitudinal movement caused by expansion and contraction might occur.

18) Adjustable Roller Hangers: For suspension of pipes, NPS 2-1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.

19) Complete Pipe Rolls: For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20) Pipe Roll and Plate Units: For support of pipes, NPS 2 to NPS 24 (DN50 to DN600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21) Adjustable Pipe Roll and Base Units: For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

C. 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: For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).

2) Carbon- or Alloy-Steel Riser Clamps: For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.

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

1) Steel Turnbuckles: For adjustment up to 6 inches (150 mm) for heavy loads.

2) Steel Clevises: For 120 to 450 degrees F (49 to 232 degrees C) piping installations.

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

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

5) Steel Weldless Eye Nuts: For 120 to 450 degrees F (49 to 232 degrees C) piping installations.

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

1) Concrete Inserts: Inserts shall be used to suspend pipe hangers from concrete ceiling. All inserts shall be pretreated to prevent rusting.

2) Beam Clamps: For attaching to flange of beams, channels, or angles.

3) Welded Beam Attachments: For attaching to bottom of beams if loads are considerable and rod sizes are large.

4) 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: 750 lb (340 kg).

b. Medium: 1500 lb (675 kg).

c. Heavy: 3000 lb (1350 kg).

5) Horizontal Travelers: For supporting piping systems subject to linear horizontal movement where head room is limited.

F. 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: To fill interior voids with insulation that matches adjoining insulation.

2) Protection Shields: 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 (690-kPa) 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.

G. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1) Restraint-Control Devices: Where indicated to control piping movement.

2) Spring Cushions: For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).

3) Spring-Cushion Roll Hangers: For equipping Type 41 roll hanger with springs.

4) Spring Sway Braces: To retard sway, shock, vibration, or thermal expansion in piping systems.

5) Variable-Spring Hangers: 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: 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: 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: Mounted horizontally.

b. Vertical: Mounted vertically.

c. Trapeze: Two vertical-type supports and one trapeze member.

3.3 HANGER AND SUPPORT INSTALLATION:

A. Pipe Hanger and Support Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Rooftop Piping and Equipment Support: Coordinate with warranty-holding roofing contractor for support pad requirements. If necessary, install a compatible sheet of roofing material (rubber pad) under support to protect roof membrane.

C. Perforated straps shall not be used in any work.

D. No piping shall be self-supporting; nor shall it be supported from equipment connections.

E. 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 Standards, steel shapes selected for loads being supported. Weld steel according to AWS Standards.

3) Pipes shall be supported on rollers.

F. Install building attachments within concrete slabs or attach to structural steel. 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.

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 Standards is not exceeded.

K. Insulated Piping: Hangers for all insulated pipe shall be oversized to accommodate the outside diameter of the insulation. Comply with the following:

1) Attach clamps and spacers to piping.

a. All Insulated Piping: Use thermal-hanger shield insert with clamp sized to match OD of insert.

b. Do not exceed pipe stress limits according to ASME Standards.

2) Install MSS 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 (DN100) 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 (DN100) 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 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.

b. NPS 4 (DN100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

c. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

d. NPS 8 to NPS 14 (DN200 to DN350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

e. NPS 16 to NPS 24 (DN400 to DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5) Pipes NPS 8 (DN200) 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.

3.4 CONCRETE PADS:

A. All equipment pads shall extend 6” larger in each overall dimension for all mechanical equipment foot prints, reference structural engineering construction documents for pad construction requirements.

3.5 EQUIPMENT SUPPORTS:

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor where indicated in drawings or specifications.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.6 METAL FABRICATION:

A. Field Welding: Comply with AWS 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.

3.7 ADJUSTING:

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

3.8 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 (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM Standards.

3.9 CUTTING AND PATCHING:

A. Excessive cutting of the building structure, walls, floors, ceilings, roof, etc., will not be permitted. No structural member shall be notched or cut unless specifically shown on the Drawings or unless such cutting is authorized by the Engineer.

End of Section 23 05 29

SECTION 23 05 48 VIBRATION ISOLATION

1.0 GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.2 SUMMARY:

A. This Section includes the following:

1) Elastomeric isolation pads and mounts.

2) Restrained elastomeric isolation mounts.

3) Freestanding and restrained spring isolators.

4) Housed spring mounts.

5) Elastomeric hangers.

6) Spring hangers.

7) Spring hangers with vertical-limit stops.

8) Thrust limits.

9) Pipe riser resilient supports.

10) Resilient pipe guides.

11) Restrained vibration isolation roof-curb rails.

12) Restraining cables.

13) Steel and inertia vibration isolation equipment bases.

1.3 DEFINITIONS:

A. Effective peak velocity related acceleration coefficient.

1.4 SUBMITTALS:

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Welding certificates.

1.5 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to AWS D1.1, Structural Welding Code--Steel.

1.6 COORDINATION:

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork.

2.0 PRODUCTS

2.1 MANUFACTURERS:

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

1) Manufacturers

a. Ace Amber/Booth Company, Inc.

b. B-Line Systems, Inc.

c. Kinetics Noise Control, Inc.

d. Mason Industries, Inc.

2.2 VIBRATION ISOLATORS:

A. Elastomeric Isolator Pads (EIP): Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1) Material: Standard neoprene.

2) Durometer Rating: 50.

B. Elastomeric Mounts (EM): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1) Durometer Rating: 50.

C. Spring Isolators (SI): Freestanding, laterally stable, open-spring isolators.

1) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2) Minimum Additional Travel: 50 percent of the required deflection at rated load.

3) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

4) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5) Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.

6) Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators (RSI): Freestanding, steel, open-spring isolators with housing.

1) Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

E. Elastomeric Hangers (EH): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

F. Spring Hangers (SH): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1) Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6) Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

G. Spring Hangers with Vertical-Limit Stop (SHVLS): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1) Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6) Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7) Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

H. Thrust Limits (TL): Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.

1) Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6) Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7) Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

I. Pipe Riser Resilient Support (PRRS): All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

J. Resilient Pipe Guides (RPG): Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.3 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS (RVIRCR):

A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand 125-mph wind impinging laterally against side of equipment.

B. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

C. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be

located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1) Restrained Spring Isolators: Freestanding, steel, open-spring isolators with housing.

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

c. Minimum Additional Travel: 50 percent of the required deflection at rated load.

d. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2) Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

a. Material: Standard neoprene.

b. Durometer Rating: 50.

D. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.4 VIBRATION ISOLATION EQUIPMENT BASES (VIEB):

A. Steel Base (VIEB-SB): Factory-fabricated, welded, structural-steel bases and rails.

1) Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

2) Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3) Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Inertia Base (VIEB-IB): Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1) Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor

slide bases or rails. Include supports for suction and discharge elbows for pumps.

2) Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3) Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4) Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.5 FACTORY FINISHES:

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1) Powder coating on springs and housings.

2) All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.

3) Baked enamel for metal components on isolators for interior use.

4) Color-code or otherwise mark vibration isolation control devices to indicate capacity range.

3.0 EXECUTION

3.1 EXAMINATION:

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. Install roof curbs, equipment supports, and roof penetrations.

B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

3.3 EQUIPMENT BASES:

A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for Project site.

1) 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.

2) Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.

3) Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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

5) Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL:

A. Testing: Perform the following field quality-control testing:

1) Isolator deflection.

2) Snubber minimum clearances.

3.5 ADJUSTING:

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

F. Torque anchor bolts according to equipment manufacturer's written recommendations.

3.6 CLEANING:

A. After completing equipment installation, inspect vibration isolation control devices. Remove paint splatters and other spots, dirt, and debris.

3.7 DEMONSTRATION:

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain mounting systems. Refer to Division 1 Section "Demonstration and Training."

3.8 VIBRATION ISOLATOR SCHEDULE:

Equipment	Isolator
Air Handler:	
Floor mounted	EIP
Suspended	SH
Motors 3 thru 10HP	SI
Motors 15 thru 30 HP	SI
Motors 40 thru 75 HP	SI
Chillers	EIP
Cooling Tower (Note 1)	EIP
Expansion Tank	EIP
Suspended Fans / Fan-Powered Boxes	SH
Piping	SH

Notes: 1. Provide intermediate structure I-Beam. Beam to be hot dipped galvanized and sized as required by tower manufacturer installation. Refer to tower manufacturer's installation instructions.

End of Section 23 05 48

SECTION 23 05 53 MECHANICAL IDENTIFICATION

1.0 GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.2 SUMMARY:

A. This Section includes mechanical identification materials and devices.

1.3 SUBMITTALS:

A. Product Data: For identification materials and devices.

B. Valve Schedules: For each piping system. Reproduce on standard-size bond paper. Tabulate valve number, piping system, system abbreviation as shown on tag, room or space location of valve, and variations for identification. Mark valves intended for emergency shutoff and similar special uses. Besides mounted copies, furnish copies for maintenance manuals.

1.4 QUALITY ASSURANCE:

A. Comply with ASME Standards, for lettering size, length of color field, colors, and viewing angles of identification devices.

1.5 SEQUENCING AND SCHEDULING:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

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

2.0 PRODUCTS

2.1 IDENTIFYING DEVICES AND LABELS:

A. General: Products specified are for applications referenced in other Division 23 Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1) Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.

2) Location: Accessible and visible.

C. Snap-On Plastic Pipe Markers (for pipe less than 125ºF): Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME Standards, unless otherwise indicated.

D. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least 3 times letter height and of length required for label.

E. Lettering: Manufacturer's standard preprinted captions as selected by Engineer.

F. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1) Arrows: Either integrally with piping system service lettering, to accommodate both directions, or as separate unit, on each pipe marker to indicate direction of flow.

G. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils (0.08 mm) thick.

1) Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.

2) Color: Comply with Standards, unless otherwise indicated.

H. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include hole for fastener.

1) Material: 1/16-inch-thick plastic laminate with 2 black surfaces and a white inner layer, or stamped brass disc with black fill lettering.

2) Size: 1-1/2-inches (40-mm) diameter, unless otherwise indicated.

3) Valve Tag Fasteners: Brass S-hooks and/or beaded chains.

I. Engraved Plastic-Laminate Signs: Fabricate in sizes required for message.

1) Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.

2) Thickness: 1/16 inch (2 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3 mm) for larger units.

3) Fasteners: Contact-type, permanent adhesive.

K. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1) Green: Cooling equipment and components.

2) Yellow: Heating equipment and components.

3) Blue: Equipment and components that do not meet criteria above.

4) Hazardous Equipment: Use colors and designs recommended by ASME.

5) Terminology: Match schedules as closely as possible. Include the following information if provided on the equipment schedules:

a. Equipment identification name (i.e. “AHU-1”).

b. Zone or system served, if specified (i.e. “Library”).

c. Design capacity (AHU CFM, boiler MBH, chiller tons, pump GPM and head, etc.).

d. Motor horsepower (verify installed motor size, may differ from design).

6) Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

3.0 EXECUTION

3.1 LABELING AND IDENTIFYING PIPING SYSTEMS:

A. Install pipe markers on each system. Include arrows showing normal direction of flow.

B. Marker Type: Plastic markers, with application systems. Install on pipe insulation segment where required for hot, noninsulated pipes.

C. Fasten markers on pipes and insulated pipes smaller than 6 inches (150 mm) OD by the following method:

1) Laminated or bonded application of pipe marker to pipe or to insulation.

D. Fasten markers on pipes and insulated pipes 6 inches (150 mm) in diameter and larger by the following method:

1) Strapped to pipe or insulation with manufacturer's standard stainless-steel bands.

E. 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 nonconcealed locations according to the following:

1) Near each valve and control device.

2) Near each branch connection, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.

3) Near penetrations through walls, floors, ceilings, or nonaccessible 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 a maximum of 50-foot (15-m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in areas of congested piping and equipment.

7) On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.2 VALVE TAGS:

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

B. The number, location, and purpose corresponding to each valve shall be listed in sequence, properly typewritten on a schedule sheet to be turned over to the Owner in a frame with glass or Plexiglas cover.

C. Valve Tag Application Schedule: Tag valves according to size, shape, color scheme, and with captions similar to those indicated in the following:

3.3 EQUIPMENT SIGNS AND MARKERS:

A. Install engraved plastic-laminate signs or equipment markers on or near each major item of mechanical equipment. Include signs for the following general categories of equipment:

1) Main control and operating valves, including safety devices and hazardous units such as gas outlets.

2) Fire department hose valves and hose stations.

3) Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

4) Pumps, compressors, condensers, and similar motor-driven units.

5) Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

6) Fans, blowers.

7) Packaged HVAC central-station and zone-type units.

8) Tanks and pressure vessels.

9) Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

3.4 ADJUSTING AND CLEANING:

A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.

B. Clean faces of identification devices and glass frames of valve charts.

End of Section 23 05 53

SECTION 23 05 93 AIR AND WATER BALANCE

1.0 GENERAL

1.1 SCOPE:

A. Testing, adjusting and balancing (TAB) of the air conditioning systems (water and air) and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed by the Owner, separate and apart from the construction contract.

B. The firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up the basic work as may be required.

1.2 QUALIFICATIONS:

A. The Firm shall be one which is organized to provide services of this specified type in the State of Texas.

B. The Firm shall have operated a minimum of two 2 years under it's current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status. The Firm shall have been NEBB certified for at least 2 years.

C. The Firm shall maintain current insurance coverages in the minimum amounts shown below. If the Firm normally carries such insurance coverages (minimum or higher) incident to its operation, additional insurance for the specific proposal or proposals is not required. The minimum insurance coverages required are:

1) Worker's Compensation as required by law.

2) General Liability for not less than $ 500,000 aggregate.

3) Fire Damage, and Extended Coverage, Vandalism and Malicious Mischief, in the full amount of Contract. The above policies shall be carried with companies satisfactory to the Owner. Certificates of each of the above policies, together with a written statement by the issuing company, stating that said policy will not be canceled without ten (10) days prior written notice to the Owner, shall be delivered to the Owner before any work is started.

D. All personnel used on the job site shall be permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.

E. The TAB firm shall submit biographical data on the individual proposed to directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air and hydronic system balancing, and shall possess properly calibrated instrumentation. All of the employees used in the TAB firm shall be permanent, full-time employees of the firm.

F. The TAB firm shall submit a sample of the final Test and Balance report from the different project and also shall submit samples of the TAB forms that will be used for this

application. All forms shall be approved by the Owner before the final TAB report is submitted and approved.

1.3 REFERENCES:

A. AABC - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, Fifth Edition 1989.

B. ASHRAE - 1991 HVAC Applications Chapter 34: Testing, Adjusting and Balancing.

C. ANSI/ASHRAE Standard 111-1988 - Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

1.4 DOCUMENTS:

A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect/Engineer to compile one set of mechanical specifications, all pertinent change orders, and the following:

1) Two complete sets of Drawings with all addenda less the structural sheets.

2) Two sets of mechanical floor plans of the conditioned spaces. These Drawings shall be ozalid type (blue or black on light background) reproductions to facilitate marking.

B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.6 through 1.10 of this Specification will be available through the Construction Inspector.

1.5 RESPONSIBILITIES OF THE TAB FIRM:

A. The TAB personnel shall check, adjust, and balance the components (air side and water side) of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service.

B. Liaison and Early Inspection:

1) The TAB firm personnel on the job shall act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:

a. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Commentary will be provided to the Owner of each observation.

2) Shall calculate new RPM’s for units with fixed sheaves or units with adjustable sheaves that are beyond the adjustment range, based on field measurements and submit new requirements to contractor. The contractor shall install the new

belts and sheaves. If the pulley needs to be replaced, provide written letter to the Owner or the General Contractor with all design and actual test data with new pulley recommendation. Data shall include design and actual total CFM, RPM's, AMP's, total static pressure and total external static pressure.

3) Upon completion of the installation and start-up of the mechanical equipment by the Mechanical Subcontractor, the Balancing Contractor will balance (air and water), test and adjust the system components to obtain optimum conditions in each conditioned space in the building During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Architect shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner. The Balancing Contractor is advised that deficiencies in HVAC construction are often encountered during final TAB services; include all time required to identify the deficiencies and to await their correction.

4) Shall change speed of the direct drive units to proper speed to bring units to design criteria. Report actual speed at fan (low/medium/high). If the total capacity exceeds the design specification (plus or minus), Contractor needs to take and provide one lower or higher speed capacity (CFM) to the designer. The designer will advise which speed to select.

5) Shall plug all drilled test holes. Seal, repair and fix insulation, per specification. During drilling test holes in the duct, contractor can not tear up the insulation. The test hole shall be used for verification of the airflow in future testing. The existing holes need to be found easily. If test holes were used for only traverse data, contractor shall provide company labels at each traverse location. Labels shall include:

a. Duct size and duct area.

b. Design air flow (velocity and CFM).

c. Actual air flow (velocity and CFM).

d. Actual static pressure.

1.6 FINAL AIR AND WATER BALANCE:

A. General Requirements.

1) When systems are complete and ready for operation, the TAB Consultant will perform a final balance for all air and water systems and record the results. Do all work required for complete testing and adjusting of all HVAC systems.

2) Provide all instruments and equipment required to accomplish necessary testing, adjusting, and as required by the Engineer to verify performance. All instruments shall be in accurate calibration and shall be calibrated in ranges that will be expected.

B. Design Conditions. The HVAC systems have been designed to maintain the inside conditions indicated on the drawings when operating with the scheduled outside conditions. Install, test and adjust the systems so that they will produce the inside conditions for design; however, contractor must be prepared to provide a suitable test to prove that equipment is producing capacities scheduled.

1) Inside Conditions.

a. Summer: 74 F.D.B. 50% R.H.

b. Winter: 72 F.D.B.

2) Outside Conditions.

a. Summer: 97 F.D.B. 77 F.W.B.

b. Winter: 25 F.D.B.

3) Switch season condition.

a. The Contractor is responsible to come back to the building when the season switched and check spot temperatures throughout the building. Contractor should provide written letter to the Owner stating that the building is performing per design condition.

C. The air quantities shown on the drawings for individual outlets may be changed to obtain uniform temperature within each zone, but the total air quantity shown for each zone must be obtained. Maximum temperature variation within a zone to be 2 F. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. In case the total air flow capacity is higher than the design, do not use all volume dampers to decrease the total capacity, adjust blower drive or change motor speed.

D. Adjust all blower drives with adjustable sheaves to obtain proper total amounts of air. Adjust drive if necessary to accomplish proper air flow.

E. Adjust valves in the various water systems to obtain proper amount of water to each piece of equipment. Adjust the design water pressure differential across each cooling and heating coil, measure total GPM's per coil, measure entering and leaving water temperature at each coil. All coils should be set for design air flow capacity during the water test. Record all actual readings.

F. Pumps (chilled) shall be tested and balance set for total design GPM capacity. The actual size impeller shall be verified and compared with design. Total capacity shall be adjusted to within $\pm$5% of the design CFM capacity. Record all actual readings.

G. Adjust total water flow through the chillers on chilled and condenser side. Set water differential pressure at chilled and condenser water. Verify water temperature at chilled side per design documents. Record all actual readings.

H. Verify and set the total water flow GPM at each electrical and gas water heater. Verify entering and leaving water temperature at each water heater. Verify and set the total water flow GPMs at each recirculation pump (if provided). Record all readings.

I. Verify the electrical, water, gas unit heater for proper KW, water flow and set water flow. Verify entering and leaving water and air temperature with design documents. Record all readings.

J. Water flows shall be balanced to ±5% of the value shown on the drawings.

K. Calibrate, set and adjust all automatic temperature controls. Check proper amount of water to each piece of equipment.

L. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and the supply or return air volume for each distribution device shall be adjusted to within ±5% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit.

M. The exhaust fans, transfer fans, kitchen hood exhaust and make-up air volume for each fan and for each distribution device shall be adjusted to within ± 5% of the valve shown on the drawing. The fan volumes shall be adjusted by changing fan speed (control speed switch) fan blower and pulleys. Measure the total air flow by duct traverse. Record all readings.

N. Heat recovery units and outside air units with associated relief fans shall be balanced to provide the difference (or more) in supply air versus exhaust air. The supply air quantity should be adjusted to the design CFM, plus 5% minus 0% and the exhaust air quantity should be adjusted to the design CFM, minus 5% plus 0% with no more than a 5% increase in the design difference. Take static pressure readings at each component of the unit on the supply and exhaust side. Take temperature readings at each component of the unit on the supply and exhaust side. Verify all readings with design documents. Measure total airflow on each side of the unit (supply and exhaust) using pitot tube traverse. (Entering and leaving side of each fan, if acceptable). Record all readings.

O. Fan coil units and rooftop units shall be balanced to design airflow. Change speed at the motor (low/medium/high) or change sheaves and belts to bring units to design capacity. Measure return airflow at each diffuser. Measure temperature across the unit in cooling and heating modes. Measure static pressure readings at each component of the unit. Balance energy recover module on RTUs similar to Heat Recovery Units described above. Record all readings.

P. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:

1) Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. Measure entering and leaving static pressure and differential pressure across the filter. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.

2) Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Division 23 Contractor shall make any required changes.

3) Pump Capacity: Measure GPM, inlet and outlet head pressure, dead head, and associated amperages at each. Provide the actual pressure differential set point if pump is equipped with VFD.

4) Chiller: Measure GPM, inlet and outlet pressure and temperature of chilled and condensing water, amperage at full load, ambient air temperature.

5) Ampere and Voltage Readings: Measure and record full load amperes and volts for motors.

6) Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, heat wheels, return air fan, air handling unit filter, make-up transfer and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.

7) Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM's (at HRU's, RTU's, FCU's, EF's, TF's) and temperatures, as applicable, at each fan, blower and coil.

8) Equipment Water Flow: Adjust and record chilled and heating water GPM's (at HRU's, AHU's, FCU's, heat exchangers etc.) and air and water temperature at design capacity entering and leaving conduit, as applicable.

9) Total Water Flow: Measure total flow of the building and compare with total flow at the chiller. Verify total water flow meter (if any). Record all readings.

10) Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures at each cooling coil, heating coil and HVAC terminal unit. Adjust total water flow at each coil and take entering and leaving water temperature. Record all readings.

11) Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.

12) Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within ±5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.

13) Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts, outside air at WSHP's, make-up ducts, RTU's, TF ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data. All traverse points shall be marked on drawing and submitted in final Test and Balance report. All traverse points shall be labeled with stickers. It should include the unit number, duct size, duct area, design CFM, design velocity, actual velocity, actual CFM and actual static pressure.

14) Heat Recovery Units: Adjust supply, return, outside air and exhaust quantities. Furnish total outside air inlet to the unit, total supply air to the space or to Rooms, RTUs or FCU's, total return from space to unit and total exhaust from unit.

1.7 SOUND VIBRATION AND ALIGNMENT:

A. Vibration: Read and record vibration for all air handling units, and fans which have motors larger than 10 HP. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed 1 mil on fans and 1 mil on pumps unless otherwise specified. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.8 TESTING OF TEMPERATURE CONTROL SYSTEMS:

A. In the process of performing the TAB work, the TAB Agency shall:

1) Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.

2) Verify that all control devices are properly connected.

3) Verify that all dampers, valves and other controlled devices are operated by the intended controller.

4) Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).

5) Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes and fire/smoke dampers.

6) Observe that all valves are properly installed in the piping system in relation to direction of flow and location.

7) Observe the calibration of all controllers.

8) Verify the proper application of all normally opened and normally closed valves.

9) Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.

10) Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control contractor will relocate as deemed necessary by the TAB Agency. (Relocate thermostats only if new location will have better control of the system. Engineer will make final decision.)

11) Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.

12) Verify that all controller setpoints meet the design intent.

13) Check all dampers for free travel.

14) Verify the operation of all interlock systems.

B. A systematic listing of the above testing and verification shall be included in the final TAB report.

1.9 REPORTS:

A. As a part of the report, submit to the Owner a letter certifying:

1) That all balancing is complete.

2) That all controls are calibrated and functioning properly.

3) That all parts of the various systems are complete and ready to be turned over to the Owner for continuous operation. Submit with letter a report tabulating data requested by the Engineer

B. The activities described in this section shall culminate in a report. Provide six (6) individually bound copies to the Owner. T & B Contractor shall provide CD (read only files) copy of the report to the Owner. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.

C. During T & B work the Owner can ask Contractor to provide actual readings for different areas if problem occur in some areas. Copy of the field notes would be acceptable.

D. The T&B contractor shall submit preliminary test and balance reports within four weeks after substantial completion. Preliminary report shall include all of the information required of the final report and may be copies of field notes in a binder. Preliminary report shall also indicate all deficiencies noted. Final Test and Balance reports shall be submitted to the Owner within four weeks of completion of all deficiencies. If any deficiencies are not corrected within two months of substantial completion the T&B contractor shall submit the Final T&B report with the deficiencies noted. Once the deficiencies are corrected the T&B contractor shall submit addenda to the Final Report to complete the report.

E. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or engineers of the firm.

F. At the option of the Architect, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Engineer. Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.

G. Submit reports on forms approved by the Owner & Engineer which will include the following information as a minimum:

1) Title Page.

2) Company Name.

3) Company Address.

4) Company telephone number.

5) Project name.

6) Project location.

7) Project Manager.

8) Project Engineer.

9) Project Contractor.

10) Project Identification Number.

C. TAB Report will normally contain the following sections:

1) Table of Contents.

2) General data and certification.

3) Brief description of tests and procedures.

4) Summary of test results (note deficiencies, if any, and action taken for correction).

5) Logs, data and records

D. Instrument List:

1) Instrument.

2) Manufacturer.

3) Model.

4) Serial Number.

5) Range.

6) Calibration date.

7) What test instrument was used for

E. Fan Data (Supply, Exhaust, Return, Transfer, Outside (Design versus Actual).

1) Location.

2) Manufacturer.

3) Model and serial number.

4) Air flow, specified and actual.

5) Total static pressure (total external), specified and actual.

6) Inlet pressure.

7) Discharge pressure.

8) Fan RPM.

9) Total traverse.

10) Amps and Volts.

11) Filter Data.

12) Air flow, specified and actual.

13) Filter size- square feet.

14) Actual entering and leaving static pressure.

15) Actual differential pressure.

16) Design static pressure of filter.

F. Return Air/Outside Air Data (If fans are used, same data as for 3 above). (Design versus Actual).

1) Identification/location.

2) Design return air flow.

3) Actual return air flow.

4) Design outside air flow.

5) Return air temperature.

6) Outside air temperature.

7) Required mixed air temperature.

8) Actual mixed air temperature.

G. Electric Motors (Name Plate versus Actual).

1) Manufacturer.

2) HP/BHP.

3) Phase, voltage, amperage, nameplate, Hz, frame.

4) RPM.

5) Service factor.

6) Starter size, HE size, HE rating.

7) VFD input, output and model number.

H. Belt and Drive.

1) Identification/location.

2) Required driven RPM.

3) Driven sheave, diameter and RPM.

4) Belt, size and quantity.

5) Motor sheave, diameter and RPM.

6) Center-to-center distance.

I. Duct Traverse.

1) System zone/branch.

2) Duct size.

3) Area.

4) Design velocity.

5) Design air flow.

6) Test velocity.

7) Test air flow.

8) Duct static pressure.

J. Air Distribution Test Sheet

1) Manufacturer.

2) Model number.

3) Air terminal number.

4) Room number/location.

5) Terminal type.

K. Terminal size (outlet size and neck size).

1) Design air flow.

2) Test (first) air flow.

3) Test (final) air flow.

4) Diffuser mark.

L. Cooling Coil Data (Design versus Actual).

1) Identification.

2) Number of Rows.

3) Quantity.

4) Manufacturer.

5) Entering air DB temperature.

6) Entering air WB temperature.

7) Leaving air DB temperature.

8) Leaving air WB temperature.

9) Delta air pressure (entering coil and leaving coil).

10) Face velocity.

11) Total air flow (CFM).

12) Entering water temperature.

13) Leaving water temperature.

14) Delta water temperature.

15) Delta WP (WG ft).

16) Total water flow GPM.

M. Balancing Valve (Circuit Setters) (Design versus Actual).

1) Manufacturer.

2) Model number.

3) Size.

4) Total GPM.

5) Entering air pressure.

6) Leaving air pressure.

7) Delta pressure (entering and leaving).

8) Number of settings/turns,

N. Heating Coil Data (Design versus Actual).

1) Identification.

2) Number of rows.

3) Quantity.

4) Manufacturer.

5) Total air flow (CFM).

6) Total water flow GPM.

7) Water pressure drop.

8) Entering air temperature.

9) Leaving air temperature.

10) Delta air pressure (entering coil and leaving coil).

O. Pump Data (Design versus Actual).

1) Service.

2) Manufacturer.

3) Size.

4) Type.

5) Shut of TDH.

6) Impeler size.

7) Discharge pressure (after final balance).

8) Suction pressure (after final balance).

9) Head ft.

10) GPM.

11) Motor Manufacturer.

12) HP.

13) PH/Hz.

14) Amps.

15) Volts.

16) RPM.

17) Starter size, HE size, HE rating.

18) VFD input, output and model number.

P. Vibration Test on Equipment having 10 HP Motors and Above.

1) Location of points:

a. Fan bearing, drive end.

b. Fan bearing, opposite end.

c. Motor bearing, center (if applicable).

d. Motor bearing, drive end.

e. Motor bearing, opposite end.

f. Casing (bottom or top).

g. Casing (side).

h. Duct after flexible connection (discharge).

i. Duct after flexible connection (suction)

Q. Test readings:

1) Horizontal, velocity and displacement.

2) Vertical, velocity and displacement.

3) Axial, velocity and displacement.

R. Normally acceptable readings, velocity and acceleration.

1) Unusual conditions at time of test.

2) Vibration source (if non-complying).

S. Control verification indicating date performed and any abnormalities identified.

1) Point Location/Description.

2) Actual Readout.

3) Interlocks.

4) Safeties.

5) Alarms.

6) Sequences of Operation

T. After Owner Occupancy.

1) After Owner has occupied and is using the building, make three additional inspections of the system (at 1 month intervals) to:

   a. Correct any Owner observed temperature imbalances.

   b. Check correct operation of equipment and verify by letter to the Engineer on each trip. List in the letter corrections made.

End of Section 23 05 93

SECTION 23 07 19 HYDRONIC PIPING INSULATION

1.0 GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.2 SUMMARY:

A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1) Division 23 Section "Hydronic Equipment Insulation" for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.

2) Division 23 Section “Hangers and Supports” for pipe insulation shields and protection saddles.

C. All insulation thicknesses will be provided as prescribed per this specification and the 2012 International Codes or ASHRAE 90.1 2007, whichever is more stringent.

1.3 SUBMITTALS:

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for the following:

1) Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.

2) Attachment and covering of heat trace inside insulation.

3) Insulation application at pipe expansion joints for each type of insulation.

4) Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5) Removable insulation at piping specialties and equipment connections.

6) Application of field-applied jackets.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

D. Submittal copies shall be forwarded to the Engineer.

1.4 QUALITY ASSURANCE:

A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to applicable ASTM standards, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1) Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

2) Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION:

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section 23 05 29, Hangers and Supports.

B. Coordinate clearance requirements with piping Installer for insulation application.

C. Coordinate installation and testing of electric heat tracing.

1.7 SCHEDULING:

A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

2.0 PRODUCTS

2.1 MANUFACTURERS:

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

1) Mineral-Fiber Insulation:

a. CertainTeed Corp.

b. Johns Manville

c. Knauf Insulation

d. Owens-Corning Fiberglas Corp.

2) Cellular-Glass Insulation:

a. Pittsburgh-Corning Corp.

3) Flexible Elastomeric Thermal Insulation:

a. Armstrong World Industries, Inc.

b. Rubatex Corp.

4) Polyolefin Insulation:

a. Armstrong World Industries, Inc.

b. IMCOA.

5) Closed Cell Phenolic-Foam Insulation:

a. Kooltherm Insulation Products, Ltd.

6) Calcium Silicate Insulation:

a. Owens-Corning Fiberglas Corp.

b. Pabco.

c. Johns Manville

2.2 INSULATION MATERIALS:

A. Mineral Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1) Preformed Pipe Insulation: Comply with applicable ASTM Standards, Type 1, with factory applied, all purpose, vapor-retarder jacket.

2) Blanket Insulation: Comply with applicable ASTM C Standards, Type II, without facing.

3) Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:

a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.

b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

4) Vapor-retarder Mastics: Fire and water resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.

5) Mineral-Fiber Insulating Cements: Comply with applicable ASTM C Standards.

6) Expanded or Exfoliated Vermiculite Insulating Cements: Comply with applicable ASTM Standards.

7) Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with applicable ASTM C Standards.

B. Cellular Glass Insulation: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.

1) Preformed Pipe Insulation, with Jacket: Comply with applicable ASTM standards (typical).

C. Flexible Elastomeric Thermal Insulation: Closed cell, sponge or expanded rubber materials. Comply with ASTM for tubular materials and sheet materials.

1) Adhesive: As recommended by insulation material manufacturer.

2) Ultraviolet Protective Coating: As recommended by insulation manufacturer.

D. Polyolefin Insulation: Unicellular polyethylene thermal plastic, preformed pipe insulation. Comply with ASTM, except for density.

1) Adhesive: As recommended by insulation material manufacturer.

E. Closed Cell Phenolic Foam Insulation: Preformed pipe insulation of rigid, expanded, closed cell structure. Comply with ASTM C.

F. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C.

G. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS:

A. General: Comply with applicable ASTM standards.

B. Foil and Paper Jacket: Laminated, glass fiber reinforced, flame retardant kraft paper and aluminum foil.

C. PVC Jacket: High impact, ultraviolet resistant PVC; 20 mils (0.5 mm) thick; roll stock ready for shop or field cutting and forming.

1) Adhesive: As recommended by insulation material manufacturer.

2) PVC Jacket Color: White or gray.

3) PVC Jacket Color: Color code piping jackets based on materials contained within the piping system.

D. Heavy PVC Fitting Covers: Factory fabricated fitting covers manufactured from 30 mil (0.75 mm) thick, high impact, ultraviolet resistant PVC.

1) Shapes: 45 and 90 degree, short and long radius elbows, tees, valves, flanges, reducers, end caps, soil pipe hubs, traps, mechanical joints, and P trap and supply covers for lavatories for the disabled.

2) Adhesive: As recommended by insulation material manufacturer.

E. Standard PVC Fitting Covers: Factory fabricated fitting covers manufactured from 20 mil (0.5 mm) thick, high impact, ultraviolet resistant PVC.

1) Shapes: 45 and 90 degree, short and long radius elbows, tees, valves, flanges, reducers, end caps, soil pipe hubs, traps, mechanical joints, and P trap and supply covers for lavatories for the disabled.

2) Adhesive: As recommended by insulation material manufacturer.

F. Aluminum Jacket: Factory cut and rolled to indicated sizes. Comply with ASTM, 3003 alloy, H 14 temper.

1) Finish and Thickness: Corrugated finish, 0.010 inch (0.25 mm) thick.

2) Moisture Barrier: 1 mil (0.025 mm) thick, heat-bonded polyethylene and kraft paper.

3) Elbows: Preformed, 45 and 90 degree, short and long radius elbows; same material, finish, and thickness as jacket.

G. Stainless Steel Jacket: ASTM, Type 304 or 316; 0.10 inch (2.5 mm) thick; and roll stock ready for shop or field cutting and forming to indicated sizes.

1) Moisture Barrier: 1 mil (0.025 mm) thick, heat bonded polyethylene and kraft paper.

2) Elbows: Gore type, for 45 and 90 degree elbows in same material, finish, and thickness as jacket.

3) Jacket Bands: Stainless steel, Type 304, 3/4 inch (19 mm) wide.

2.4 ACCESSORIES AND ATTACHMENTS:

A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, pre-sized a minimum of 8 oz./sq. yd. (270 g/sq. m).

1) Tape Width: 4 inches (100 mm).

B. Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:

1) Stainless Steel: ASTM, Type 304; 0.020 inch (0.5 mm) thick.

2) Aluminum: 0.007 inch (0.18 mm) thick.

C. Wire: 0.062 inch (1.6 mm), soft annealed, stainless steel.

2.5 VAPOR-RETARDERS:

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

3.0 EXECUTION

3.1 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION:

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS:

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor-retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor-retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

1) Apply insulation continuously through hangers and around anchor attachments.

2) For insulation application where vapor-retarders are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor-retarder.

3) Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.

4) Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor-retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor-retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:

1) Pull jacket tight and smooth.

2) Circumferential Joints: Cover with 3 inch (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.

3) Longitudinal Seams: Overlap jacket seams at least 1 1/2 inches (40 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

a. Exception: Do not staple longitudinal laps on insulation having a vapor-retarder.

4) Vapor-retarder Mastics: Where vapor-retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.

5) At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with vapor-retarder mastic.

P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1) Seal penetrations with vapor-retarder mastic.

2) Apply insulation for exterior applications tightly joined to interior insulation ends.

3) Extend metal jacket of exterior insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.

4) Seal metal jacket to roof flashing with vapor-retarder mastic.

Q. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

S. Fire Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire rated walls and partitions.

T. Floor Penetrations: Apply insulation continuously through floor assembly.

1) For insulation with vapor-retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor-retarder.

3.4 MINERAL FIBER INSULATION APPLICATION:

A. Apply insulation to straight pipes and tubes as follows:

1) Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.

2) Where vapor-retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor-retarder to ends of insulation at intervals of 15 to 20 feet (4.5 to 6 m) to form a vapor-retarder between pipe insulation segments.

3) For insulation with factory applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

4) For insulation with factory applied jackets with vapor-retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1) Apply preformed pipe insulation to outer diameter of pipe flange.

2) Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral fiber blanket insulation.

4) Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1) Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2) When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.

3) Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1) Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2) When pre-molded insulation sections are not available, apply glass fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.

3) Apply insulation to flanges as specified for flange insulation application.

4) Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

5) For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 CELLULAR GLASS INSULATION APPLICATION:

A. Apply insulation to straight pipes and tubes as follows:

1) Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.

2) Where vapor-retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.

3) For insulation with factory applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

4) For insulation with factory applied jackets with vapor-retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1) Apply preformed pipe insulation to outer diameter of pipe flange.

2) Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular glass block insulation of the same thickness as pipe insulation.

4) Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1) Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2) When pre-molded sections of insulation are not available, apply mitered sections of cellular glass insulation. Secure insulation materials with wire, tape, or bands.

3) Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1) Apply pre-molded segments of cellular glass insulation or glass fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.

2) Apply insulation to flanges as specified for flange insulation application.

3) Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

4) For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.6 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION:

A. Apply insulation to straight pipes and tubes as follows:

1) Follow manufacturer's written instructions for applying insulation.

2) Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1) Apply pipe insulation to outer diameter of pipe flange.

2) Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.

4) Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1) Apply mitered sections of pipe insulation.

2) Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1) Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.

2) Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.

3) Apply insulation to flanges as specified for flange insulation application.

4) Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.7 POLYOLEFIN INSULATION APPLICATION:

A. Apply insulation to straight pipes and tubes as follows:

1) Follow manufacturer's written instructions for applying insulation.

2) For split tubes, seal longitudinal seams and end joints with manufacturer's recommended adhesive.

3) For self adhesive insulation, staple longitudinal seams after sealing. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1) Apply pipe insulation to outer diameter of pipe flange.

2) Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of the same thickness as pipe insulation.

4) Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1) Apply mitered sections of polyolefin pipe insulation.

2) Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1) Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.

2) Apply cut segments of polyolefin pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.

3) Apply insulation to flanges as specified for flange insulation application.

4) Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.8 CLOSED CELL PHENOLIC FOAM INSULATION APPLICATION:

A. Apply insulation to straight pipes and tubes as follows:

1) Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.

2) Where vapor-retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.

3) For insulation with factory applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

4) For insulation with factory applied jackets with vapor-retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1) Apply preformed pipe insulation to outer diameter of pipe flange.

2) Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.

4) Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1) Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2) When pre-molded sections of insulation are not available, apply mitered sections of phenolic foam insulation. Secure insulation materials with wire, tape, or bands.

3) Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1) Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2) When pre-molded sections of insulation are not available, apply mitered segments of phenolic foam insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.

3) Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

4) For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.9 CALCIUM SILICATE INSULATION APPLICATION:

A. Apply insulation to straight pipes and tubes as follows:

1) Secure each layer of insulation to pipe with stainless steel bands at 12 inch (300 mm) intervals and tighten without deforming insulation materials.

2) Apply two layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062 inch (1.6 mm), soft annealed, stainless steel wire spaced at 12 inch (300 mm) intervals. Secure outer layer with stainless steel bands at 12 inch (300 mm) intervals.

3) Apply a skim coat of mineral-fiber, hydraulic setting cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.

B. Apply insulation to flanges as follows:

1) Apply preformed pipe insulation to outer diameter of pipe flange.

2) Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.

4) Finish flange insulation the same as pipe insulation.

C. Apply insulation to fittings and elbows as follows:

1) Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2) When pre-molded sections of insulation are not available, apply mitered sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.

3) Finish insulation of fittings the same as pipe insulation.

D. Apply insulation to valves and specialties as follows:

1) Apply mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without

disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.

2) Apply insulation to flanges as specified for flange insulation application.

3) Finish valve and specialty insulation the same as pipe insulation.

3.10 FIELD-APPLIED JACKET APPLICATION:

A. Apply glasscloth jacket, where indicated, directly over bare insulation or insulation with factory applied jackets.

1) Apply jacket smooth and tight to surface with 2 inch (50 mm) overlap at seams and joints.

2) Embed glass cloth between two 0.062 inch (1.6 mm) thick coats of jacket manufacturer's recommended adhesive.

3) Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.

1) Draw jacket material smooth and tight.

2) Apply lap or joint strips with the same material as jacket.

3) Secure jacket to insulation with manufacturer's recommended adhesive.

4) Apply jackets with 1 1/2 inch (40 mm) laps at longitudinal seams and 3 inch (75 mm) wide joint strips at end joints.

5) Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Apply PVC jacket where indicated, with 1 inch (25 mm) overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.

D. Apply metal jacket where indicated, with 2 inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.11 FINISHES:

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.12 PIPING SYSTEM APPLICATIONS:

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1) Flexible connectors.

2) Vibration-control devices.

3) Fire-suppression piping.

4) Drainage piping located in crawl spaces, unless otherwise indicated.

5) Below-grade piping, unless otherwise indicated.

6) Chrome-plated pipes and fittings, unless potential for personnel injury.

7) Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.13 FIELD QUALITY CONTROL:

A. Inspection: Perform the following field quality control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:

1) Inspect fittings and valves randomly selected by Architect.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.14 INSULATION APPLICATION SCHEDULE, GENERAL:

A. Refer to insulation application schedules for required insulation materials, vapor-retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

C. Use the application scheduled thickness within this specification or appropriate 2006 International Code, whichever is more stringent.

3.15 INTERIOR INSULATION APPLICATION SCHEDULE:

A. Chilled-water supply and return:

1) Operating Temperature: 35 to 75 degrees F (2 to 24 degrees C).

2) Insulation Material: Mineral fiber with jacket.

3) Insulation Thickness: Apply the following insulation thicknesses:

a. Steel or Copper Pipe, up to 1": 1 ½"

b. Steel or Copper Pipe, 1 ¼" to 2": 1 ½"

c. Steel or Copper Pipe, 2 ¼ and larger: 1 ½"

4) Field-Applied Jacket: Foil and paper.

5) Vapor-retarder required: Yes.

6) Finish: None.

B. Refrigerant liquid suction and hot gas piping:

1) Operating Temperature: 35 to 50 degrees F (2 to 10 degrees C).

2) Insulation Material: Mineral fiber.

3) Insulation Thickness: Apply the following insulation thicknesses:

a. Copper Pipe, up to ¾ ": ½ thick.

b. Copper Pipe, 1" and larger, 1 ½ " thick.

4) Field-Applied Jacket: PVC

5) Vapor-retarder required: No.

6) Finish: None.

C. Condenser water supply and return within conditioned spaces will not be insulated.

D. Condenser water supply and return underground will not be insulated.

E. Condenser water supply and return within exterior conditions will be insulated as follows:

1) Operating Temperature: 75 to 100 degrees F (2 to 24 degrees C).

2) Insulation Material: Close celled phenolic foam with aluminum jacket.

3) Insulation Thickness: Apply the following insulation thicknesses:

a. Steel or Copper Pipe, up to 1": 1"

b. Steel or Copper Pipe, 1 ¼" to 2": 1 ½"

c. Steel or Copper Pipe, 2 ¼ and larger: 2"

F. Heating hot water supply and return:

1) Operating Temperature: 100 to 200 degrees F (38 to 93 degrees C).

2) Insulation Material: Mineral fiber with jacket.

3) Insulation Thickness: Apply the following insulation thicknesses:

a. Steel or Copper Pipe, up to 1": 1 ½"

b. Steel or Copper Pipe, 1 ¼" to 2": 1 ½"

c. Steel or Copper Pipe, 2 ¼" and larger: 2"

4) Field-Applied Jacket: Foil and paper.

5) Vapor-retarder required: No.

6) Finish: None.

3.16 EXTERIOR INSULATION APPLICATION SCHEDULE:

A. This application schedule is for aboveground insulation outside the building.

B. Refrigerant liquid and suction:

1) Operating Temperature: 35 to 50 degrees F (2 to 10 degrees C).

2) Insulation Material: Flexible elastomeric.

3) Insulation Thickness: Apply the following insulation thicknesses:

a. Copper Pipe, all sizes: ½”

4) Field-Applied Jacket: None.

5) Vapor-retarder required: No.

6) Finish: Manufacturer-recommended UV-protective coating.

C. Condenser water supply and return:

1) Operating Temperature: 50 to 105 degrees F (10 to 40 degrees C).

2) Insulation Material: Cellular glass, with jacket.

3) Insulation Thickness: Apply the following insulation thicknesses:

a. Steel Pipe, up to 1”: 1”.

b. Steel Pipe, 1 ¼” to 2”: 1 ½”

c. Steel Pipe, 2 ¼” and larger: 2”.

4) Field-Applied Jacket: Aluminum.

5) Vapor-retarder required: Yes.

6) Finish: None.

End of Section 23 07 19

SECTION 23 21 13 HYDRONIC PIPING

1.0 GENERAL

1.1 SYSTEM DESCRIPTION:

A. Furnish and install all piping of every kind required, specified, or shown on the drawings for the installation of the Mechanical work. The location, direction, and size of the various lines are indicated on the drawings. Lines for pilot and controls and instrumentation are not shown but shall be installed as required and as specified.

B. Piping systems shall include all appurtenances shown on the drawings and/or specified in other Division 23 sections.

C. Valves shall be installed to control flow to each of the various systems, to segregate individual items of equipment and parts of fluid circulating or supply systems, and to permit draining of systems or portions thereof, to blow-off strainers, etc., as directed on the drawings and/or specified.

D. The work shall include the furnishing and installing of all required supporting structures and members.

E. Support devices and members shall include vibration and noise isolating devices and assemblies. Penetrations of mechanical room walls shall be sealed off to limit noise transmission through sleeves.

1.2 QUALITY ASSURANCE:

A. All piping and materials shall be new and of the best quality.

B. All piping and materials shall be installed in a workmanlike manner by experienced installers.

1.3 SUBMITTALS:

A. Submit shop drawings and product data in accordance with Section 23 05 00, Mechanical General Provisions. Include list outlining piping materials and fittings to be used on each system as applicable. Indicate joining methods for different piping systems to be installed.

B. Welding Certificates: Copies of certificates for welding procedures and personnel.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1) Test procedures used.

2) Test results that comply with requirements.

3) Failed test results and corrective action taken to achieve requirements.

1.4 PRODUCT HANDLING:

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction will be rejected.

B. Keep all open ends of piping in each system plugged or capped to prevent dirt or other debris from entering the pipe at any and all times during construction and/or before fixtures or equipment is connected. All piping shall be flushed clear prior to connection to the central building systems.

C. Storage and protection of materials shall be as specified in Section 23 05 00, Mechanical General Provisions.

1.5 COORDINATION:

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.

C. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

2.0 PRODUCTS

2.1 COPPER TUBE AND FITTINGS:

A. Drawn-Temper Copper Tubing: ASTM Type L (ASTM Type B).

B. Annealed-Temper Copper Tubing: ASTM Type K (ASTM Type A).

C. DWV Copper Tubing ASTM Type K (ASTM Type A).

D. Wrought-Copper Fittings.

E. Wrought-Copper Unions.

F. Solder Filler Metals: ASTM 95-5 tin antimony.

G. Brazing Filler Metals: AWS Classification BAg-1 (silver).

2.2 STEEL PIPE AND FITTINGS:

A. Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade A, Schedule 40, black steel, plain ends.

B. Steel Pipe, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): ASTM A 53, Type E (electric-resistance welded), Grade A, Schedule 40, black steel, plain ends.

C. Steel Pipe, NPS 14 through NPS 18 (DN 350 through DN 450): ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.

D. Steel Pipe, NPS 20 (DN 500): ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 20, black steel, plain ends.

E. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 (DN 50) and smaller and electric-resistance welded for NPS 2-1/2 (DN 65) and larger.

F. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.

G. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 230 and 300.

H. Malleable-Iron Unions: ASME B16.39; Classes 230, 250, and 300.

I. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

J. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

K. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1) Material Group: 1.1.

2) End Connections: Butt welding.

3) Facings: Raised face.

2.3 PIPING AND FITTING APPLICATIONS:

A. Steel pipe 2-1/2" and larger shall have plain ends to be assembled by welding, or have grooved mechanical-joint couplings. Steel pipe 2” and smaller shall generally have threaded ends, except where special requirements dictate otherwise.

B. In general, the following listed materials shall be used in fabricating the piping systems. Where special classes of piping are involved and are not listed, the Contractor shall request instructions as to the class of material involved and the method of fabricating before ordering the materials.

1) Chilled Water and Heating Water: Type "L" hard drawn copper ½” to 2”. Schedule 40 steel 2-1/2” and larger.

2) Condenser Water: Type "L" hard drawn copper ½” to 2”. Schedule 40 steel 2-1/2” and larger.

3) Condensate Drains: Type "L" hard drawn copper or Schedule 40 PVC.

4) Atmospheric Relief Lines: Type "L" hard drawn copper.

5) Miscellaneous Lines: Pilot, bleed, control, sampling, and equalizing lines and similar auxiliary lines shall be fabricated of the material used in the system to which they are connected in each case. Drains from appurtenances installed in copper lines shall be of Type "L" hard drawn copper tubing. Other drains shall similarly match the piping system materials.

6) Chemical treatment piping and valves shall be schedule 40 PVC up to final connections to the main system which shall be schedule 40 PVC.

C. In general, fittings used for the various piping systems shall be as listed below. Special fittings shall be used where required by job conditions and when approved for particular use.

1) Welding Fittings:

a. All fittings in welded lines shall be factory fabricated welding fittings of the same material and the same schedule or weight as the piping system in which installed. All elbows, reducers, tees, caps and special fittings shall be standard factory fabricated butt welding fittings, conforming to ANSI B16.9.

b. Branch takeoffs from lines 2½" in size and larger and where the size of the takeoff does not exceed two-thirds of the nominal diameter of the mains to which connected may be made with shaped nipples or with Weldolets or Threadolets as required by the class of fabrication.

c. Mitering of pipe to form elbows, notching of straight runs to from tees, or any similar construction shall not be permitted.

2) Screwed Fittings in Steel Lines: 150 lb. black malleable iron banded pattern screwed fittings.

3) Miscellaneous Fittings: provide all reducers, increasers, adapters, bushings, etc., as required to properly interconnect the various items, to change sizes, etc. Steel fittings shall be used in steel lines, and copper and red brass fittings shall be used in copper lines.

4) All elbows shall be long radius unless noted otherwise.

D. All welds and fittings shall have the same bursting pressure as pipe of the same size and schedule at minimum.

E. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.4 FLANGES:

A. Flanges in welded lines shall be 150 pound forged steel, welding neck flanges, except where cast iron fittings are used as specified elsewhere in these specifications, and except as otherwise shown or required by conditions which might necessitate the use of slip-on welding neck flanges. Obtain prior approval for use of slip-on flanges in specific instances where necessitated, otherwise none shall be used.

B. Flanges in screwed ferrous lines shall be 125 pound cast iron or 150 pound forged steel screwed flanges.

C. Where ferrous flanges connect to flat-faced flanges on valves, items of equipment, etc., the companion flange shall be flush faced. Where the flanges on items of equipment are raised face flanges, the companion flanges shall have raised faces.

D. Flanges in copper lines shall be solder joint type cast brass flanges.

E. Flange bolts and nuts shall conform to the applicable requirements of the latest edition of the Code for Pressure Piping.

2.5 GASKETS:

A. Install gaskets between flanges of all flanged joints. Where used with brass or bronze flanges or with flat face ferrous flanges, they shall be full face type. For all other flanges they shall be ring gaskets properly cut to fit within the inside edges of the bolts.

B. Gaskets shall be suitable for the application as specified by the manufacturer.

2.6 INSULATING FITTINGS:

A. Wherever an interconnection is made between ferrous pipes or vessel and copper tubing or brass pipe, or vice versa, install a dielectric fitting. Exception: no dielectric fitting shall be installed in connections between copper or brass and sanitary cast iron waste, drain and vent lines. In lines assembled with screwed or soldered joints, use insulating couplings and where flanged connections are required, use insulating gasket material between flange faces, insulating grommets between bolts and holes in flanges and insulating washers under both bolt heads and nuts.

B. Dielectric fittings and insulating couplings shall be rated for the pressure and temperature of the system installed.

2.7 FLEXIBLE CONNECTORS:

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1) 2-Inch NPS (DN50) and Smaller: Threaded.

2) 2-1/2-Inch NPS (DN65) and Larger: Flanged.

3) Option for 2-1/2-Inch NPS (DN65) and Larger: Grooved for use with keyed couplings.

B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 degrees F. Units may be straight or elbow type, unless otherwise indicated.

2.8 EXPANSION JOINTS:

A. Packed, Slip, Expansion Joints: 230-psig (1035-kPa) minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.

3.0 EXECUTION

3.1 GENERAL PIPING INSTALLATIONS:

A. All piping shall be installed at proper grades. Chilled water, heating water and condensate lines shall grade down to drains. All steam and return lines and the vents and their drains shall pitch down a minimum 1" in 40 feet. Install piping free of sags and bends.

B. Piping shall follow as closely as possible the routes shown on the plans and take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

C. Exposed lines shall be run parallel with, or perpendicular to building lines and wherever possible shall be grouped together for easy service and identification. Whenever possible, horizontal and vertical runs shall be held as close as possible to the walls, ceilings, struts, members, etc., so as to occupy the minimum space consistent with the proper installation requirements for insulation, conduit, ductwork, lighting fixtures, etc.

D. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected. All piping shall be supported by hangers independently of equipment connections. Swing joints or expansion loops shall be provided wherever shown on the drawings or wherever else necessary to allow for the expansion and contraction of piping.

E. Install piping to allow for necessary access to valves, other pipes, conduits, dampers, etc.

F. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. Refer to Division 23 Section 23 05 00, Mechanical General Provisions, for pipe penetration and fire-barrier requirements.

G. Valves required for control or isolation of any part of the various systems shall be provided and shall be located in approved or accessible positions or made accessible through removable panels, etc., and where several valves are related as to function, they shall be grouped together.

H. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

I. Install air vents at high points in piping.

J. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

K. Welding shall be done by mechanics that satisfy qualification requirements of the American Welding Society. The pipe ends to be welded shall be machine beveled wherever possible. Gas cuts shall be true and free from all burred metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no metal shall project within the pipe.

L. Miter joints will not be allowed in any case. All headers, connections, elbows, reducers, flanges, and special flanges and special fittings shall be made using forged steel welding fittings of the same weight as the pipe to which they are attached. All unions and connections to valves 2¾" and larger shall be made by the use of welded flanges.

M. All screw joints shall be made with taper threads properly cut. Joints shall be made tight with graphite and oil applied to the pipe threads only and not to the fittings.

N. Dielectric couplings shall be installed where ferrous lines join copper lines, without exception.

O. Unions: Provide and install unions at proper points to permit removal of pipe and various equipment and devices without injury to other parts of systems. Provide unions at equipment connections, coils, valves, and other special pieces of apparatus. Unions with 2" and smaller lines shall be ground joint and all 2" and larger unions shall be flanged unions. Unions shall be the same material and strength as other fittings in the lines. Companion flanges on lines at various items of equipment, machines, and pieces of apparatus shall serve as unions to permit removal of the particular item.

3.2 CROSS CONNECTION AND INTERCONNECTIONS:

A. No plumbing fixtures, device, or piping shall be installed which will provide a cross connection or interconnection between a distributing water supply for drinking or domestic purposes and a polluted supply such as heating, chilled, or condenser water, drainage system, or a soil or waste pipe which will permit or make possible the back-flow of sewage, non-potable, polluted water, or waste into the water supply system.

3.3 UNDERGROUND PIPING PROTECTION:

A. The Mechanical Contractor shall protect the entire surface of all underground steel piping against rust and corrosion. For piping not specified elsewhere to be furnished with factory applied pipe corrosion resistant wrapping, the piping surfaces shall be cleaned of rust, dirt, etc., with a wire brush and shall be free of oil and grease and completely dry. Brush on, or otherwise apply as recommended by the manufacturers, a heavy full coating of TC Mastic (Tape Coat Company, Evanston, Illinois) or Reilly Protective Tar Enamel No. 3302 (Reilly Tar and Chemical Company, Indianapolis, Indiana). Dry coating shall be not less than twelve (12) mils thickness. Protect freshly covered surfaces with earth for at least 12 hours as recommended by the manufacturer and depending on the weather.

3.4 TESTING AND REPAIRING:

A. Each Contractor shall, at his own expense, during the progress of the work or upon its completion, make such tests of his work as are herein specified, or as required by the Engineer, or by State or Municipal Bureaus having jurisdiction and under their supervision.

B. The Contractor shall provide all apparatus, temporary piping connections, or any other requirements necessary for such tests. He shall take all due precautions to prevent damage to the building and its contents incurred by such tests as he will be required to repair and make good, at his own expense, any damage so caused. Testing of insulated piping shall be done before insulation is applied.

C. Perform any other tests as may be required by the Engineer to indicate the fulfillment of the specifications.

D. Prepare hydronic piping according to ASME Standards and as follows:

1) Leave joints, including welds, uninsulated and exposed for examination during test.

2) Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3) Flush system with clean water. Clean strainers.

4) Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install

blinds in flanged joints to isolate equipment install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

E. All steam and water piping shall be hydrostatically tested to a pressure of 100 PSIG or to 1.5 times the operating pressure, whichever is the greatest, for six (6) hours.

F. Systems shall be tested in portions as required by the construction schedule and the portions being tested shall be effectively isolated and sealed off. When previously tested sections are connected into other sections, tests shall be rerun to include the new connections.

G. Partial systems shall be tested prior to connecting into existing lines.

H. Leaks in screwed joints shall be repaired by tightening the joint until the leak has stopped, or by remaking the joint if tightening fails to stop the leak. Leaks in welded joints shall be repaired by chipping out the weld around the leak and re-welding until it is stopped. Leaks in caulked joints shall be stopped by additional caulking of the joint, but, if that fails, the joint shall be remade. A leak in a compression joint shall be repaired by remaking the joint using a new seal, compression ring, coupling, etc. as required. Leaks in soldered joints shall be repaired by remaking the joint and no soldering or brazing over existing joints will be permitted. Any defective piping shall be replaced.

I. Additional testing shall be as specified in the individual Sections of this Specification.

3.5 CLEANING:

A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

End of Section 23 21 13

SECTION 23 64 30 MAGNETIC BEARING AIR COOLED CHILLERS

1.0 GENERAL

1.1 SUMMARY:

A. This section includes design, performance criteria, refrigerants, controls and installation requirements for magnetic bearing air cooled centrifugal chillers.

1.2 QUALITY ASSURANCE:

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a workmanlike manner by experienced installers.

C. Compliance is with the following codes and standards:

a. ARI 550/590 NEC ANSI/ASHRAE 15
b. ASME Section VIII ETL Listed
c. ANSI UL 1995

1.3 SUBMITTALS:

A. Dimensioned plan and elevation drawings, including required service clearances and location of all field piping and electrical connections.

B. Electrical and water quality requirements during operation, standby and shutdown.

C. Control system diagram showing points for field interface and connection to external BEMS systems. Drawing shall show field and factory wiring.

D. Installation and Operation Manuals.

E. Manufacturers certified performance data as per AHRI at full load and IPLV or NPLV.

1.4 PRODUCT HANDLING:

A. Chillers shall be delivered to the job site completely assembled (unless otherwise specified).

B. Compliance shall be with the manufacturer’s instructions for transportation and rigging.

1.5 WARRANTY AND MAINTENANCE

A. The chiller manufacturer warranty shall be for a period of one year from the date of equipment startup or 18 months from the date of shipment, whichever occurs first.

B. The warranty shall include parts and labor costs for the repair or replacement of parts found to be defective in material or workmanship.

C. Maintenance of the chiller equipment while under warranty, is mandatory and shall be the responsibility of the installing contractor until such time that the installation has been completed and accepted by the Owner.

2.0 PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturers: Smardt Inc. or Engineer approved equal.

2.2 PRODUCT DESCRIPTION:

A. Provide and install as shown on the plans, a factory assembled air cooled packaged chiller.

B. Each unit shall have one or more oil-free magnetic bearing and variable speed centrifugal compressors. Integrated variable frequency drive shall operate with inlet guide vanes to optimize part load efficiency. Chillers shall operate with HCF-134a refrigerant.

C. The evaporator, condenser and expansion valve shall be configured to operate as a single refrigerant circuit unless otherwise specified. The chiller unit compressors shall be designed for mechanical and electrical isolation to facilitate service and removal.

D. Acoustics: Sound pressure for the unit shall not exceed 83 dBA, measured at 3.28 feet according to AHRI Standard 370.

E. Chiller shall be equipped for single point power connection.

2.3 CHILLER COMPONENTS:

A. Compressors shall be of semi-hermetic centrifugal design and operate oil-free with two stages of compression, magnetic bearings, movable inlet vanes and integrated variable frequency system.

B. Automatically positioned and controlled inlet guide vanes shall operate with compressor speed controls.

C. The compressor shall be capable of coming to a controlled stop in the event of a power failure. The unit shall be capable of initializing an automatic restart in the case of a power failure.

D. Each compressor shall have integrated microprocessor control capable of capacity and safety control.

E. Each compressor shall be installed with individual suction, discharge and motor cooling refrigerant line isolation valves.

F. Each compressor shall have an individual disconnect switch. On chillers that are provided with more than one compressor, each compressor shall have mechanical and electrical isolation to allow the chiller to operate when a compressor is removed.

G. Evaporator shall be shell and tube type and shall be designed and constructed, tested and stamped according to the requirements of the ASME Code, Section VIII Case 1518-5. Refrigerant shall be in the shell and water inside the tubes. The water sides shall be designed for a minimum of 150 psig or as specified. Vents and drains shall be provided. The refrigerant shall bear the ASME Code stamp. Vessels shall pass a test pressure of 1.1 times the working pressure but not less than 689 kPa (100 psig). Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor

suction ports. The evaporator water connections shall also be equipped with right-hand or left-hand connection, interchangeable.

H. A perforated plate designed for vapor disengagement shall be installed inside the evaporator above the tubing, to ensure effective liquid droplet removal, to prevent liquid damage to compressors, and to equalize suction pressure across evaporators with multiple compressors.

I. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.

J. Minimum evaporator exiting water temperature shall be 3.3°C (38°F). Minimum entering condenser air temperature shall be 0°C (32°F). Minimum inlet condenser air to outlet chilled water difference shall be -11.1°C (12°F).

K. The evaporator, including chilled water boxes, compressor suction line, compressor end bell, and all other components, subject to condensing moisture, shall be insulated with UL recognized ¾ inch closed cell insulation. All joints and seams shall be sealed to form a vapor barrier.

L. Air cooled packaged chillers and controls shall be capable of reliable operation between 0°C (32°F) and 40.6°C (105°F) ambient air temperature.

M. Condenser coils and fans shall be arranged such that one fan operates with one coil section so that the failure of a fan will not affect the CFM across any coil beyond that fan. The standard coating shall meet ASTM B117 2000hr salt spray test.

N. The condenser shall be equipped with an oversized liquid line and mechanical float to ensure liquid sub-cooling necessary for effective cooling of the compressor.

O. The condenser shall be equipped with packaged fixed or variable speed fans capable of delivering specified CFM of air according to ARI standard operating conditions. The fan motors shall be high efficiency, direct drive, 3-phase, insulation class “F”, current protected, Totally Enclosed Air Over (TEAO), double sealed and with permanently lubricated ball bearings.

P. The fans shall be low sound. They shall be balanced dynamically and statically and direct drive. Also, the blades shall be corrosion resistant designed for low noise, full airfoil cross section, providing vertical air discharge from extended orifices. The guards shall be constructed of heavy duty 14 gauge steel and painted.

Q. Control of refrigerant flow shall utilize a single or multiple 6,000 step electronic expansion valve (EXV), to operate within the full range from full load to the lowest loading capacity for the chiller. Fixed orifice metering devices or float controls using hot gas bypass are not acceptable. The EXV liquid line shall have a sight glass with moisture indicator and temperature sensor connected to the control system for validation of sub-cooling.

R. The condenser shall be provided with a capacitive type liquid level transducer with a resolution of not less than 1024 discrete steps. The transducer shall be wired to the chiller control system. Condenser liquid level measurement shall be used in the electronic expansion valve control algorithm with a minimum level set point to ensure adequate liquid seal is maintained in the condenser, to provide compressor motor cooling during

operation. Condenser liquid level shall be clearly displayed on the graphical operator interface in a minimum of two screens. Chillers without direct level measurement are prohibited, due to possible over heating damage that may occur in compressors when liquid seal is lost.

S. Each compressor shall be installed with individual suction, discharge, and motor cooling refrigerant line isolation valves.

T. To prevent unit operation with no water flow, factory mounted and wired thermal dispersion water flow switches shall be provided on the condenser.

U. The condenser shall be equipped with a mechanical stainless steel float for electronic actuation of the EXV, so as to provide a positive liquid seal to ensure effective cooling of the compressor.

V. The evaporator shall be provided with spring loaded reseating type pressure relief valves, in accordance with ASHRAE-15. Rupture discs are not acceptable.

W. Load balancing valves shall be provided for capacity control and additional temperature stability.

X. There shall be a backup superheat control on the inlet of the compressor, in order to control the EXV in the event of a failure of the primary level sensing device.

Y. A permanent-magnet, synchronous hermetically sealed motor of sufficient size to effectively provide compressor horsepower requirements. The motor shall include soft-start capabilities. The motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.

Z. The compressor motor and chiller unit shall include variable frequency speed controls to match cooling load demand to compressor speed and inlet guide vane position.

AA. Each compressor shall be equipped with an AC line reactor and individual disconnect.

BB. All components shall be mounted onto a unitized construction, having a galvanized welded steel frame suitable for outdoor installation.

CC. Compressors and controls shall be contained within a sheet metal enclosure to protect critical components from the weather.

DD. The controller fitted to the oil-free centrifugal chiller package shall be an embedded real time microprocessor device that utilizes control software written specifically for chiller applications. User operation shall be accomplished using a panel mounted color touch-screen interface. The status of the compressors and all system parameters, including compressor alarms and temperature trends, shall be viewable.

EE. The chiller control system shall have the capability of storing one year of operational data. No less than 60 points of information shall be sampled at a maximum of 15 minute intervals.

FF. The chiller control system shall have full web based remote control capability; including the capability of remote operation and software updates.

GG. Selectable control mode – leaving chilled water, entering chilled water, or suction pressure control.

HH. Chiller controls shall be native BacNet capable via MSTP or IP. Addition of gateway devices or additional processors or pluggable PCBs to achieve BacNet communications to the BAS is strictly prohibited.

II. Complete configuration of native BAS communications via Modbus RTU, Modbus TCP/IP, BacNet MSTP and BacNet IP shall be made via standard chiller controller graphical user interface. Chiller controls that utilize external software configuration tools to configure these protocols are explicitly prohibited.

JJ. Chiller control panel user interface shall be capable of remote control via an internet connection without the use of any third party gateway device or additional hardware or software.

KK. Real time chiller control processor shall be capable of e-mailing a predefined list of recipients, should a fault occur. E-mail shall include details of fault, possible reason for fault, attachment of monthly data log of 195 or more compressor and chiller variables, and at a minimum interval of 30 seconds and with indication of severity of fault.

LL. Ability to place all outputs in a manual state (hand, off, auto) via graphical user interface.

MM. Alarm screen shall be capable of filtering faults into specific categories such as compressor, chiller and system faults in order to provide rapid diagnosis, and separation of failure modes.

NN. Chiller control software shall employ an active fault avoidance algorithm to reduce chiller capacity and/or power level in the case of the chiller approaching within 10% of any trip limit value such as suction pressure, discharge pressure, chiller amp limit, leaving chilled water temperature limit, etc..

3.0 EXECUTION

3.1 INSTALLATION:

A. Install per manufacturer's IOM documentation, shop drawings, and submittal documents.

B. Align chiller on foundations or mounting rails as specified on drawings.

C. Arrange piping to enable dismantling and permit head removal for tube cleaning.

D. Coordinate electrical installation with electrical contractor.

E. Provide all material required for a fully operational and functional chiller.

3.2 STARTUP

A. Units shall be field charged with ant. HFC-134a refrigerant.

B. Factory Start-Up Services: Provide factory supervised start-up on-site for a minimum of two working days and ensure proper operation of the equipment. During the period of start-up, the factory authorized technician shall instruct the Owner's representative in proper care and operation of the equipment.

SECTION 26 05 00 ELECTRICAL GENERAL PROVISIONS

1.0 GENERAL

1.1 SCOPE:

A. The work covered by Division 26 includes the furnishing of all materials, labor, transportation, tools, permits, fees, utilities, and incidentals necessary and the complete installation of all electrical work required in the Contract Documents and specified herein. The intent of the Contract Documents is to provide an installation complete in every respect. In the event that additional details or special construction may be required for the work indicated or specified in Division 26 or work specified in other Divisions of the Specifications, it is the responsibility of the Contractor to provide all material and labor which is usually furnished with such systems in order to make the installation complete and operational. Include all cost associated with a power system study and the required testing.

B. The Contractor is responsible for the coordination and proper relation of his work to the building structure and to the work of other trades. The Contractor shall advise the Architect/Engineer of any discrepancy prior to bidding.

1.2 CODES AND STANDARDS:

A. All work shall comply with the latest adopted edition of the applicable rules and regulations of the National Electrical Code (NEC), the National Electrical Safety Code (NESC), Americans with Disabilities Act (ADA), the terms and conditions of service of the electrical utility, as well as any other authorities that may have lawful jurisdiction pertaining to the work specified. None of the terms or provisions of this specification shall be construed as waiving any of the rules, regulations, or requirements of these codes or authorities.

B. The Contractor shall resolve any code violation discovered in the Contract Documents with the Architect/Engineer prior to award of the contract. Any code violation in the Contract Documents discovered after award of the Contract shall be corrected to the satisfaction of the Engineer and Owner at no additional cost.

C. In any instance where the Drawings or Specifications call for materials of a better quality or larger size than required by the codes, those provisions of the Drawings or Specifications shall take precedence. The codes shall govern in case of direct conflict between the codes and the Drawings or Specifications.

1.3 RELATED DOCUMENTS:

A. The Drawings and Specifications, the General Conditions, Supplementary General Conditions and other requirements of Division 01, apply to the work specified in Division 26, and shall be complied with in every respect. The Contractor shall examine all of the documents which make up the Contract Documents, and shall coordinate them with the work on the Electrical Plans and in Division 26 of these Specifications.

1.4 DRAWINGS AND SPECIFICATIONS:

A. The Specifications are accompanied by Drawings for the project and details of the installations indicating the locations of equipment, outlets, light fixtures, switches, controls, receptacles, etc. The Drawings and Specifications are complementary to each other, and what is required by one shall be as binding as if required by both. Should the

drawings or specifications conflict, the Contractor shall install/comply with the larger or more stringent requirement.

B. If any departures from the Contract Documents are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted in writing to the Architect/Engineer for review. No departures from the Contract Documents shall be made without prior written approval of the Architect/Engineer.

C. The interrelation of the Specifications, Drawings, and Schedules is as follows: The Specifications determine the nature, installation procedures, and quality of the materials, the Drawings show in schematic form, with the use of symbols and notes, the quantity, general location, sizes, and interconnections of the various devices required to accomplish the electrical system for this project, and the Schedules give the performance characteristics. Should the Drawings disagree in themselves, or with the Specifications, the better quality or greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Architect/Engineer in writing, shall be performed or furnished. In case the Specifications should not fully agree with the Schedules, the latter shall govern. Figures indicated on Drawings govern scale measurements and large scale details govern small scale Drawings.

D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on the Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

E. Contractor will be responsible for determining the actual dimensions, equipment connection requirements, proper routing and coordinate with other divisions of work so that the electrical system is an integral part of the project. Architectural and Mechanical drawings shall be used to determine exact locations of fixtures, devices and equipment.

1.5 ELECTRICAL UTILITIES:

A. The contract documents reflect the general location, voltage, ampacity, size and manner of routing for all utilities known to be required on this project. The exact design, including but not limited to: conduit types, sizes, quantities and routing, concrete encasement specifications, pull rope(s), ground rod(s), concrete pad(s), physical protection such as bollard(s), etc. is per each individual utility. It is the responsibility of the Contractor to visit the site and confirm with each individual utility the exact requirements for all electrical, telephone and cable television utilities. The bid submitted by the Contractor shall include costs for all such coordination work as well as any and all electrical, telephone and cable television company charges and/or fees.

1.6 TEMPORARY SERVICES:

A. If no electrical service exists on this site which may be used for construction power, it is the responsibility of the Contractor to furnish and install a complete system for temporary construction power and lighting. Temporary services shall be installed in accordance with requirements of the National Electrical Code (NEC), the National Electrical Safety Code (NESC), and the Occupational Safety and Health Act (OSHA). The Contractor shall pay for the cost of the temporary construction power and lighting systems.

B. The Contractor shall pay for all electrical energy consumed by the temporary systems on the job site throughout the entire construction period.

C. Remove all temporary services upon completion of the work.

1.7 BUILDING CONSTRUCTION:

A. It is the responsibility of the Contractor to review the Drawings and Specifications so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.

B. The electrical drawings are diagrammatic in character and cannot show every connection in detail or every line or conduit in its exact location. The Contractor shall carefully investigate structural and finish conditions and shall coordinate with all other trades and existing conditions in order to avoid interference between the various phases of work.

C. The approximate location of electrical items is indicated on the electrical drawings. These drawings are not intended to give complete and exact details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the job site and will in all cases be subject to the approval of the Architect/Engineer. The Architect/Engineer reserves the right to make any reasonable changes in the location indicated without additional cost. In this situation, “reasonable” shall be defined as relocation of the electrical work in question or conflict to the nearest location that will resolve the conflict and satisfy the Owner.

D. No asbestos will be installed at this site.

1.8 CONTRACTOR QUALIFICATIONS:

A. An acceptable Contractor for the work under this Division shall be a specialist in this field and have the personal experience, training, skill and the organization to provide a practical working system. If required, he shall be able to furnish acceptable evidence of having contracted for and installed not less than three systems of comparable size and type to this one, that have served their Owners satisfactorily for not less than three years.

B. The foreman or superintendent for this work shall have had experience in installing not less than three such systems and shall be approved by the Architect/Engineer before the work is begun. Adequate and competent supervision shall be provided to ensure first class workmanship and installation.

C. Work shall be executed and all materials installed to present a neat appearance when completed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen.

D. The Contractor is responsible for all construction techniques required for all systems specified and shown on the drawings.

1.9 OBSERVATION OF THE WORK:

A. Architect/Engineer's and/or Owner's authorized representative shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect/Engineer's representative. Recommendations made by observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced to the satisfaction of the Architect/Engineer.

1.10 SUBMITTALS:

A. Comply with the requirements of Division 01.

B. Review is only for general conformance with design concept of project and general compliance with the Contract Documents. Contractor is responsible for conforming and correlating equipment dimensions at job site; for information which pertains to fabrication processes or construction techniques; and for coordination of work of all trades. Review of submittals shall not relieve the Contractor any Subcontractor, and/or Material Supplier of responsibility for deviation from requirements of Contract Documents, nor for errors or omissions in submittals. Any material provided by the Contractor without submittals reviewed by the Architect/Engineer is at the Contractor's risk and constitutes the Contractor's agreement to comply with the Architect/Engineer's intent whether specified, shown, or implied.

C. Submittal of shop drawings, product data, and samples will be accepted only when they are submitted by the Contractor. Each submittal shall indicate by signed stamp that the submittals have been checked and that they are in accordance with contract documents and that dimensions and relationship with work of other trades have been checked. Submittals that have not been checked and signed by the Contractor will be returned for checking before being reviewed.

D. Organize data in a hardback, 3-ring binder (½" minimum) with the project title shown on the spine and front cover and sections indexed by specification number. Show any revisions to equipment layouts required by use of selected equipment. Type of submittal data is listed in the individual sections of this Division.

E. Submittals provided for lighting fixtures, safety switches/disconnects, motor starters, switchboards, panelboards, and transformers shall explicitly indicate, by use of unique identifier, equipment for which device is proposed to be utilized with or on. Examples of acceptable identifiers include, but are not limited to, Equipment Connection Schedule I.D. Tags/Marks, Lighting Fixture Schedule Fixture Types, Switchboard/ Panelboard I.D. tags, etc. Submittals provided without these identifying marks clearly denoted on equipment cutsheets and Bill of Material shall constitute acceptable grounds for submittal rejection without review. The Contractor shall refer to each individual specification section for additional submittal requirements.

1.11 SUBSTITUTIONS AND PRODUCT OPTIONS:

A. Within 30 days after contract date, submit to Architect/Engineer a complete list of major products proposed to be used, with the name of the manufacturer and the installing Subcontractor.

B. Contractor's Options:

1) For products specified only by reference standard, select any product meeting that standard.

2) For products specified by naming several products or manufacturers, select any one of the products or manufacturers named, which complies with the specifications.

3) For products specified by naming one or more products or manufacturers and "or equivalent," Contractor must submit a request for substitutions for any product or manufacturer not specifically named.

4) For products specified by naming only one product and manufacturer, there is no option, unless explicitly allowed in an individual section of these Specifications.

C. “Basis of Design” manufacturers' names and catalog numbers specified under sections of Division 26 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of equivalent design to that specified for listed and approved manufacturers will be acceptable upon approval by the Architect/Engineer. The Architect/Engineer will consider written requests for substitution of specified products, if received fourteen business days prior to bid date and allowed by the Owner and these Specifications. After bid date, request for substitution will be considered only in cases of product unavailability or other conditions beyond control of the Contractor. It is the Contractor's responsibility to:

1) Personally investigate the proposed substitute product to determine that it has all the same accessories and is equivalent or superior in all respects to that specified.

2) Provide the same guarantee for the substitution that he would for that specified.

3) Coordinate the installation of the equipment which he proposes to substitute with all trades and includes the costs for any changes required for the work to be complete in all respects. The Contractor will prepare shop drawings where required by the Architect/Engineer or where dimensions vary.

4) Provide itemized cost breakdown including material and labor for the proposed product substitutions.

5) Submit complete design and performance data.

NOTE: Substitution requests are not allowed for select items. Refer to each individual Specification Section for more information.

1.12 PROJECT RECORD DOCUMENTS:

A. Throughout progress of the work of this Contract, maintain an accurate record of all changes in the Contract Documents. Upon completion of the Work of this Contract, transfer the recorded changes to a set of reproducible Record Documents. Delegate the responsibility for maintenance of Record Documents to one person on the Contractor's staff. Thoroughly coordinate all changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to properly show the change. Accuracy of records shall be such that future search for items shown in the Contract Documents may reasonably rely on information obtained from the approved Record Documents. Make all entries within 24 hours after receipt of information.

B. The Contractor will mark all deviations on a daily basis. The Architect/Engineer will visit the site periodically and may request to see the "As-Built" documentation. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect/Engineer. Mark the drawings with a colored pencil. Record installed feeder conduits, dimensioning the exact location and elevation of the conduit.

C. Deliver record drawings to the Architect/Engineer in the number and manner specified in Division 01, General Requirements.

1.13 OPERATION AND MAINTENANCE DATA:

A. Prepare and submit sets of product data, shop drawings, wiring diagrams, instructions and parts lists for operating and maintaining equipment and systems installed. Include in the instructions a description of normal adjustments and a list of items to be lubricated. Specify the type and frequency of lubrication required. Provide special servicing tools as required for this equipment. Deliver manuals and tools to the Architect/Engineer as a condition of final acceptance. Refer to Division 01 for other requirements. The manual shall include:

1) Manufacturer's installation instruction brochures.

2) Manufacturer's local representative and/or distributor's name and address.

3) Manufacturer's operating and maintenance brochures.

4) Manufacturer's internal wiring diagram.

5) Contractor's installation wiring diagram.

6) Control system installation drawings.

7) Replacement part number listings and/or descriptions.

8) Framed operating instructions when required.

9) Manufacturer's warranties and guarantees.

B. The manual shall include all of the above listed data bound into a permanent hard-back, three ring binder(s) identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of Building, the Owner, the Architect, the Engineer, the General Contractor, and the Contractors installing equipment represented in the brochure.

C. Contents of the manual shall be grouped in sections according to the various sections of Division 26, and shall be listed in a Table of Contents. Sections shall be organized as follows:

1) Each "tab" in the brochure shall identify the grouping of all literature required for a single class of equipment; i.e., "transformers", "lighting fixtures", "switchgear", etc., for all types of equipment on the job.

2) Contents under each "tab" shall refer to a single class of equipment, and shall be arranged in the following sequence: First, the manufacturer's installation brochure; second, the manufacturer's operating and maintenance brochure; third, the manufacturer's installation wiring diagram; fourth, the Contractor's field wiring diagram, if different; and fifth, the manufacturer's brochure listing replacement part numbers and description.

3) Provide final tab "Warranties and Guarantees" behind which all such items will be located.

D. Upon completion of the work and at a time designated by the Architect/Engineer, instruct the Owner's operating personnel in operation and maintenance of electrical equipment

and systems. Before proceeding with instruction, prepare a typed outline in triplicate listing the subjects that will be covered. Submit the outline for review by the Architect/Engineer. At the conclusion of the instruction, obtain the signatures of the people instructed on each copy of the outline to signify that they have a proper understanding of the operation and maintenance of the system. Submit the signed outlines to the Architect/Engineer as a condition of final acceptance. Provide a minimum of 8 hours of general instruction in addition to any time specified in other sections of Division 26.

E. Deliver operations and maintenance data to the Architect/Engineer in the number and manner specified in Division 01, General Requirements.

1.14 Permits:

A. Contractor shall obtain and pay for all permits required by the “Authority Having Jurisdiction” as pertains to Division 26 work.

2.0 PRODUCTS

2.1 CONSTRUCTION MATERIALS:

A. All materials shall be new and shall conform to the requirements of the National Electrical Code and/or the Standards Organizations regulating those products and shall be listed or labeled by Underwriters Laboratories. The listing or labeling by Underwriters Laboratories will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of a UL listing, the Contractor may submit a statement from a nationally recognized, independent testing agency acceptable to the local authority and Owner’s insurance company, indicating that the items have been tested in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

B. Any asbestos that has been previously identified at the site will be clearly identified. If the contractor encounters any suspect asbestos containing material, the contractor shall stop work and immediately contact the owner and engineer.

2.2 STANDARD PRODUCTS:

A. All materials and equipment shall be standard catalog products of domestic manufacturers regularly engaged in the manufacture of products conforming to these specifications. Materials and equipment shall have been in satisfactory use at least two years prior to bid opening. Where custom or special items are required, these shall be fully described by drawings and/or material list which detail the item proposed for use on this project.

2.3 MANUFACTURERS INSTRUCTIONS:

A. The Contractor is fully responsible for furnishing the proper electrical equipment and/or material and for seeing that it is installed as intended by the manufacturer's written instructions. If needed for proper installation, operation, or start up, the Contractor shall request advice and assistance from a representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning all materials and equipment. The Contractor shall promptly notify the Architect/Engineer in writing of any conflict between the requirements of the contract documents and the manufacturer's directions and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor

perform any work that does not comply with the manufacturer's directions or instructions from the Architect/Engineer, he shall bear all costs arising in connection with correcting the deficiencies to the satisfaction of the Engineer and Owner.

2.4 RUST PREVENTION:

A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus shall be given a rust inhibiting treatment and standard finish by the manufacturer. All parts such as boxes, bodies, fittings, guards, and miscellaneous parts shall be protected by galvanizing, except where other equivalent protective treatment is specifically approved in writing.

2.5 DELIVERY AND STORAGE:

A. The Contractor shall not deliver any equipment to the job site until the equipment is ready to be installed or until there is suitable space provided to properly protect equipment from weather, humidity, dust, and physical damage.

B. All equipment shall be protected in accordance with the manufacturer's recommendations and the requirements of NFPA 70B, Annex J, titled "Equipment Storage and Maintenance During Construction."

C. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of final acceptance, shall be replaced by the Contractor at no additional expense to the Owner.

2.6 CAPACITIES AND SPACE LIMITATIONS:

A. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions. Where approved equipment requires electrical power other than that indicated in the contract documents for the specified equipment, the Contractor is responsible for adjusting protective devices, starter sizes, conductors, conduits, etc., to accommodate the approved device's electrical requirements.

B. The Contractor is responsible to verify that the equipment he proposes to provide will physically fit within the space indicated on the contract documents and that the required code clearances and maintenance access are maintained. Any space conflicts shall be noted in the submittals. Provide scale drawings to the Architect/Engineer indicating proposed solutions to any space conflict for the Architect/Engineer's review and approval.

2.7 NAMEPLATES:

A. Each piece of equipment shall have a nameplate from the manufacturer with the following information: name, address, catalog number, voltage, phase, full load amperes or horsepower, and/or other pertinent information on a plate securely attached to the equipment. All data on nameplates shall be legible at the time of final observation. Refer to specification Section 26 05 53, Electrical Identification.

B. All electrical distribution equipment shall have mechanically fastened, engraved phenolic panel labels and typed directories of the loads served.

3.0 EXECUTION

3.1 PROTECTION OF EQUIPMENT:

A. During construction, protect switchgear, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately upon receiving the products and maintain continuously.

B. Keep products clean by elevating above ground or floor and by using suitable coverings.

C. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

D. Protect factory finish from damage during construction operations and until acceptance of the project. Restore any finishes that become marred or damaged to the satisfaction of the Owner and Architect/Engineer.

3.2 INSTALLATION:

A. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work. The Contractor is responsible to coordinate with other trades in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades. Provide coordination drawings showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

B. Install minimum 3-1/2-inch thick concrete housekeeping pads for indoor floor-mounted equipment, except where direct floor mounting is required. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3-inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer. Refer to the structural engineering documents for all housekeeping pad structural requirements, including, but not limited to: rebar or other reinforcements, concrete strength, etc.

C. All equipment shall be installed level and plumb. Sheet metal enclosures shall be separated from walls a minimum 1/2-inch by installing corrosion-resistant spacers or metal framing. Provide corrosion-resistant bolts, nuts and washers to anchor equipment.

D. Permanently seal outdoor equipment at the base using concrete grout. Seal or screen openings into equipment to prevent entrance of animals, birds and insects. Use galvanized steel or copper mesh with openings not larger than 1/16-inch for screened openings. Seal small cracks and openings from the inside with a silicone sealing compound.

E. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:

1) Where shown or specified to be exposed. Exposed is understood to mean open to view.

2) Where exposure is necessary to the proper function.

3) Where size of materials and equipment preclude concealment.

4) Where replacing and/or reusing exposed electrical work.

F. All equipment shall be installed in accordance with NECA 1. All electrical equipment shall be installed in such a manner as to allow removal for service without disassembly of other equipment. Manufacturer's required access shall be provided in addition to any code required clearances.

G. Install all electrical equipment so that clearances are adhered to as required by the latest adopted version of the National Electrical Code.

3.3 HOISTING, SCAFFOLDING, AND TRANSPORTATION:

A. The Contractor shall provide his own hoisting, scaffolding and ladders as required to set his materials and equipment in place.

B. The Contractor shall provide all necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job.

3.4 CLEANING:

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. Debris shall be removed, not only from the building, but also from the site and from any public area adjacent to the site.

B. At completion of the project, the Contractor shall remove all of his tools, scaffolding, and surplus materials.

3.5 CONDUIT SLEEVES AND PENETRATION SEALS:

A. Where conduits pass through walls or floors not on fill, galvanized sheet metal sleeves shall be used. In walls, they shall be flush with each finished surface. In floor slabs, sleeves shall extend 1-1/2" above floor slab and be cemented in a water tight manner. Size of sleeves shall be at least 1/2" greater than outside diameter of the conduit.

B. For conduits passing through outside walls into interior spaces, furnish and install galvanized steel sleeves having an inside diameter at least 4" greater than the outside diameter of contained conduit. Where sleeves occur in walls having a waterproof coating applied, the sleeves shall have flanges welded onto them to build into the waterproofing. After conduits are installed, the annular space between the conduit and sleeve shall be effectively sealed with an approved mastic sealer as directed by the Architect/Engineer.

C. Sleeves and flashings compatible with the roofing installation shall be provided for roof penetrations or anchorage of supports. All roof penetrations and anchorage details shall be reviewed and approved by the Roofing Consultant and/or Architect/Engineer.

3.6 FIREPROOFING:

A. All raceways, cables, cable tray, etc. passing through fire rated floors and/or walls shall have the void area between the material passing through floor and/or wall sealed with an approved fire-stop material to maintain the fire rating of the floor and/or wall.

3.7 COORDINATION:

A. Additional Work:

1) The Contractor shall be advised that additional work will be required of the Contractor by other project consultants and trades. This may include, but is not limited to the following consultants and contractors, if applicable to the project:

   a. Architect (for both architecturally specified equipment and Owner furnished equipment).

   b. Technology (voice/data/etc.).

   c. Fire alarm.

   d. audio/visual.

   e. security (intrusion and detection and cameras).

   f. public address and sound system.

   g. clock and bell system(s).

   h. irrigation.

   i. landscape architect.

   j. civil engineer.

   k. mechanical and plumbing engineer(s).

   l. acoustics.

   m. Controls.

   n. door hardware contractor.

   o. kitchen consultant and contractor.

   p. furniture consultant and contractor.

   q. Others as included in the Construction Documents

2) Prior to bid, the Contractor shall obtain a complete set of project documents, including any and all addenda, and carefully review and coordinate the requirements and provisions specified by each individual trade. Where items requiring electrical connections are explicitly or implicitly specified by other consultants and not explicitly shown or noted on the electrical documents, the Contractor shall provide the necessary circuit(s) from the nearest panelboard of the correct voltage and phase with sufficient spare capacity. The Contractor shall provide all necessary items required by all other consultants and trades to form complete and operable systems. This includes, but is not limited to all: junction boxes, raceway systems, face plates, identifying tags and labels, conductors, terminations, circuit breakers, transformers, disconnects, fuses, enclosures, etc.

3.8 ELECTRICAL CONNECTIONS TO MOTORS AND EQUIPMENT:

A. Contractor shall coordinate with all other Divisions of these Specifications as required to verify all electrical requirements of those Divisions. This is to include but not be limited to verification of power, voltage, phase and other characteristics as being compatible with that called for on the electrical drawings and Division 26 Specifications, as well as that called for in other Divisions of the Specifications requiring electrical connections. This shall be done prior to placing orders for equipment or material, and prior to any rough-in, etc. Changes arising from this coordination exercise shall not create any cost to the project.

B. Motors are specified in other Divisions of the Specifications. Electrical work includes the electrical connection of all motors, except those which are pre-wired by the manufacturer as a part of equipment. Connection of motors specified in other Divisions of the Specifications or Drawings, but not reflected on electrical drawings shall be included in Division 26 scope of work. Where connections are not shown on electrical drawings, include in bid supply circuiting from nearest panel of required voltage and unless indicated otherwise:

1) Motors, less than 3/4 hp: 120Vac single-phase. (See Motor Schedule on drawings.)

2) Motors, 3/4 hp and above: 480Vac three-phase. (See Motor Schedule on drawings.)

3) Space heating elements up to 1.8 kW: 120Vac single-phase.

4) Space heating elements rated 1.8 kW to 4 kW: 277Vac single-phase.

5) Space heating elements rated above 4 kW: 480Vac three-phase.

6) Point-of-use water heaters less than 3 kW: 120Vac single-phase.

7) Domestic water heaters greater than 3 kW and less than 4.5 kW: 208Vac single-phase.

8) Domestic water heaters greater than 4.5 kW: 480Vac three-phase.

9) Kitchen equipment, hardwired: coordinate with kitchen consultant Contract Documents.

10) Fluorescent lighting: 277Vac single-phase, unless noted otherwise on the drawings or if lighting fixture is installed below 8’-0” above the finished floor.

11) Exterior lighting above twenty-two feet: 480Vac single-phase.

12) Special purpose receptacles: Verify with each individual piece of equipment.

13) General purpose receptacles: 120Vac single-phase.

14) All others as required to provide a complete and operable system.

C. Contractor shall be responsible for providing, installing and locating a magnetic motor starter with overloads, disconnect or VFD for each motor or Div. 23 piece of equipment provided on the project unless device is integral to the motor/equipment or provided by the vendor supplying the motor/equipment. Overloads shall be sized for the motor HP or as recommended by the manufacturer for the piece of equipment to be provided. Motors

or equipment located interior to the building shall be provided with a combination starter/disconnect switch located within sight and no more than 15' from motor/equipment. Exterior mounted motors or equipment shall be provided with a separate magnetic motor starter located inside of the building in a conditioned and accessible location acceptable to the engineer and owner, plus a separate enclosed disconnect switch mounted adjacent to the exterior motor or equipment. Disconnect shall not be mounted or screwed into the unit housing but mounted on a galvanized steel channel support assembly securely attached to the adjacent roof, wall or slab. Motor overloads may be removed from the magnetic motor starters if provided integral to the local disconnect supplied by the vendor or another Division. See Division 23 Documents for additional information. Contractor shall provide all required code clearances and coordinate with Division 23 Contractor for device location recommendations. Separately enclosed and mounted starters will not be required when shown on the drawings as part of a Motor Control Center assembly.

D. Contractor shall provide and install a fused disconnect at each of the following locations:

1) Each piece of Division 23's equipment where the manufacturer or nameplate requires fuses.

2) On the secondary side of each dry type transformer where the low voltage panel main breaker is out of sight or has more than 25' of secondary conductor length. Disconnect shall be mounted adjacent to the transformer. Contractor is responsible for maintaining all code clearances.

3.9 EMERGENCY POWER DISTRIBUTION:

A. Emergency Feeder-Circuit wiring as defined by the National Electrical Code Article 700, shall be installed in areas fully protected by a automatic fire suppression system, or protected by a listed thermal barrier, or installed in a minimum 1 hour listed assembly, or embedded in not less than 2 inches of concrete, or be a cable UL listed for a minimum 1 hour fire rated integrity when installed in accordance with the listing requirements.

B. Emergency Distribution System Equipment, such as transfer switches, transformers, panelboards or other enclosed overcurrent devices shall be located in spaces fully protected by an approved automatic fire suppression system or in spaces with a minimum 1 hour fire resistance rating.

3.10 CUTTING AND PATCHING:

A. When it becomes necessary to cut through any wall, floor, or ceiling to install any work under the Contract, or to repair any defects that may appear up to the expiration of the guarantee period, such cutting shall be done by the Contractor. The Contractor will not be permitted to cut or modify any structural members without the written permission of the Owner.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades caused by cutting or by the failure of any part of the work installed under this Contract, shall be performed by the appropriate trade and shall be paid for by the Contractor. Restore the surface to match the adjacent surfaces to the satisfaction of the Owner, Architect and Engineer. Obtain approval of restoration prior to submitting Substantial Completion Pay Application. Failure to do so may result in the contracting of a third party to perform the work. This Contractor will be held responsible for complete payment of third party Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements. All openings shall be waterproofed upon completion of the work as specified by the Architect/Engineer. Any openings through fire rated walls or floors shall be sealed to maintain the minimum fire rating of wall or floor penetrated.

3.11 VIBRATION ISOLATION:

A. The Contractor shall furnish and install vibration isolation means for all equipment and materials furnished under the Contract to prevent the transmission of perceptible vibration and structure borne or air borne noise to occupied areas. Items requiring vibration isolation shall include:

1) All transformers shall be mounted on one inch (1") thick cork rib pads and/or rubber or steel spring isolator units properly sized, spaced, and loaded, which in turn shall rest on a 3 1/2" minimum concrete base.

2) Where transformers are to be suspended from the structure above, each hanger shall be equipped with double-deflecting steel spring and rubber in-shear anti-vibration hangers. The rubber in shear mounting for each hanger shall provide a static deflection at least equivalent to the static deflection for a 1/4" rubber pad. Anti-vibration mountings shall be equipped with adequate leveling mechanisms which do not interfere with proper hanger operation.

3) Raceway systems shall be isolated from all dry type transformers and rotating or reciprocating machinery. Install 12" of flexible metal conduit per 1" of conduit diameter. The minimum length of flexible conduit used for isolation shall be 12" and the maximum length shall not exceed 36".

3.12 CONDITIONS OF EQUIPMENT AT FINAL ACCEPTANCE:

A. At time of acceptance, the Contractor shall have inspected all installed systems to assure the following have been completed:

1) Fixtures are operating; lamps, lenses and reflectors are free of dust, debris, and fingerprints.

2) Panelboards have all conductors neatly formed, laced and made up tight. Enclosures shall be vacuum cleaned, surfaces clean of stray paint, dust, grease and fingerprints. All circuit directories to be typewritten, completed, and in place.

3) Wall plates and exposed switch and receptacle parts to be clean, free of paint, plaster, etc.

4) Disconnect switches and motor starters shall be vacuum cleaned, surfaces clean of stray paint, dust, grease and fingerprints.

5) Service entrance equipment, transformers, generators, automatic transfer switches, and system devices shall be cleaned internally and externally and have all surfaces restored to initial surface conditions.

6) Touch-up all scratched surfaces using paint matching the existing equipment paint. Where paint cannot be matched the entire surface shall be repainted in a color and manner approved by the Architect/Engineer.

7) All electrical equipment shall be identified as specified under these Specifications.

8) All electrical system testing requirements have been performed, verified, documented, and reviewed by the Architect/Engineer.

3.13 WARRANTIES:

A. Comply with the requirements of Division 01.

3.14 GUARANTEE:

A. The Contractor shall guarantee all materials and workmanship for a period of twelve (12) months after the final acceptance of work.

End of Section 26 05 00

SECTION 26 05 19 600 VOLT INSULATED CONDUCTORS

1.0 GENERAL

1.1 SCOPE:

A. This section specifies the furnishing and installation of 600 volt insulated conductors.

1.2 REFERENCE STANDARDS:

A. ICEA S-95-658 (NEMA WC 70) - Non-Shielded Power Cable Rated 2000 V or Less.

B. UL 83 - Thermoplastic-Insulated Wires and Cables.

C. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

D. NECA 1 - 2000 - Standard Practices for Good Workmanship in Electrical Contracting (ANSI)

1.3 APPLICABLE PROVISIONS:

A. Refer to Section 26 05 00, Electrical General Provisions.

1.4 SUBMITTALS:

A. None required.

1.5 DELIVERY, HANDLING AND STORAGE:

A. Deliver conductors properly packaged in factory-fabricated containers, or wound on NEMA-standard type wire and cable reels.

B. Handle conductors carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of conductors is maintained prior to and upon completed installation.

C. Store conductors in a clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

2.0 PRODUCTS

2.1 600-VOLT INSULATED CONDUCTORS:

A. Conductors shall be soft-drawn annealed copper with conductivity of not less than 98% at 20 degrees C (68 degrees F).

B. Unless indicated otherwise on the drawings, the following minimum wire and conduit size shall be provided for the indicated breakers for conductor lengths (phase and neutral) of 100’ or less.

1) 1P - 20, See this Specification Section, 2.1.E, three conductor, ¾” C.

2) 2P - 20, See this Specification Section, 2.1.E, four conductor, ¾” C.

3) 3P - 20, See this Specification Section, 2.1.G, five conductor, ¾” C.

4) 1P - 30, 2#10 & #10G., ¾" C.

5) 2P - 30, 3#10 & #10G., ¾"C.

6) 3P - 30, See Conductor Chart on drawings, Provide 'B30' U.N.O.

7) 1P - 40, 2#8 & #10G., ¾"C.

8) 2P - 40, 3#8 & #10G., ¾"C.

9) 3P - 40, See Conductor Chart on drawings, Provide 'B40' U.N.O.

C. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

E. Where 120 volt branch circuit conductor length (phase + neutral) exceeds 100', minimum #10 conductor shall be used. Where 277 volt branch circuit conductor length (phase + neutral) exceeds 200', minimum #10 conductor shall be used

F. 120 volt and 277 volt 20 amp branch circuits shall be a minimum #12 conductor, typically 2#12 & #12 G. in a minimum 3/4" C. shall comprise a single circuit unless indicated otherwise on the drawings.

G. Where the drawings indicate or Contractor installs, multiple phase conductors sharing a single neutral, the overcurrent device shall be multiple pole with a single lever to disconnect all phases on the shared circuit when any one phase needs to be turned off.

H. Provide two ground conductors in metallic raceways or cables connected to receptacles shown as Isolated Ground 'IG'.

a. Furnish factory-colored insulation for conductors or with a field applied tape.

I. Conductors shall be permanently marked to indicate voltage, insulation type and temperature rating and size in accordance with NEC Article 310.11. Ensure these markings are visible at all terminations and accessible locations along the conductor's length.

2.2 CONDUCTOR REQUIREMENTS:

A. Service Entrance: Type THWN-2, single conductors in raceway or Type XHHW, single conductors in raceway

B. Exposed Feeders: Type THWN-2, single conductors in raceway.

C. Feeders Concealed in interior dry Ceilings, Walls, and Partitions: Type THWN-2, single conductors in raceway. UL Listed Metal-clad cable, Type MC with full sized green insulated ground wire may be used for circuits less than 50 amps.

D. Feeders or Branch Circuits in wet locations or Concealed in Concrete, below Slabs-on-Grade, crawl spaces and Underground: Type THWN-2 or XHHW-2, single conductors in raceway.

E. Feeders or Branch Circuits Installed below Raised Flooring: Type THWN-2, single conductors in raceway. UL Listed Metal-clad cable, Type MC with full sized green

insulated ground wire may be used for circuits less than 50 amps. Provide two full sized insulated ground wires for any isolated ground (IG) feeders or branch circuits.

F. Feeders or Branch Circuits in Cable Tray: Type THWN-2, single conductors in raceway. UL Listed Metal-clad cable, Type MC with full sized green insulated ground wire may be used for circuits 50 amps and less. Provide two full sized insulated ground wires for any isolated ground (IG) feeders or branch circuits.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

H. Class 1 Control Circuits: Type THWN-2, in raceway.

I. Class 2 Control Circuits: Type THWN-2, in raceway, Power-limited cable, concealed in building finishes or Power-limited tray cable, in cable tray.

J. Fire alarm wiring including signal line circuits (SLC) from control panel to addressable interface modules, initiation device circuits (IDC) to addressable initiation appliances and notification appliance circuits (NAC) to audio and/or visual appliances, control wiring shall be enclosed in metallic raceway except above drop ceilings or concealed in walls where UL listed Fire Alarm MC cable with red-stripe, 105 degree C with up to 3 hour through wall fire penetration rating shall be used.

3.0 EXECUTION

3.1 INSTALLATION:

A. Mechanically protect conductors by installing in raceway. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1. Completely and thoroughly swab raceway before installing wire.

B. Route wire and cable as required to meet project conditions. Wire and cable routing indicated is diagrammatic, contractor to determined exact feeder or branch circuit routing in field. Contractor to be responsible for determining exact routing and lengths required.

C. Use wiring methods indicated. Not more than three alternate phase conductors may share a common neutral. Provide dedicated circuits and neutrals (one phase per neutral) for branch circuits as follows: 1) connected to a “K” rated transformer, 2) connected to a ground fault (GFCI) or arc fault (AFCI) circuit breaker or, 3) other single phase circuit where connecting multiple phases to a common neutral will adversely effect the operation of the supplied load. Only circuits connected to single phase general purpose receptacle or lighting branch circuits rated a maximum 20 Amps may be combined. Contractor shall confirm with the building Owner that connecting multiple phases to a common neutral is acceptable, authorization shall be provided in writing. At no time shall two conductors/circuits of the same phase share a common neutral. Multiple pole single handle breakers shall be used when more than one phase shares a neutral.

D. Pull all conductors into raceway at same time.

E. Clean conductor surfaces before installing lugs and connectors.

F. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

G. All building feeders shall be continuous from switchboard to panel, panel to panel as well

as branch circuits from panel to outlet, utilization device or equipment for conductor lengths 250' or less. Feeder and branch circuit conductor splices will not be allowed for one way lengths less than 250'.

H. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

I. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

J. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

K. Neatly and securely bundle all conductors in enclosures using nylon straps with a locking hub or head on one end and a taper on the other.

L. At least 6 inches (measured from the finished surface) of each conductor shall extend outside a box’s opening.

M. Two or three pole breakers with common handle operation shall be provided where phases are combined sharing a common neutral.

N. Install no more than three phase conductors of different phases, a neutral or neutrals for IG and SPD and a grounding conductor in a single raceway unless specifically noted on the drawings.

O. Use equipment homerun circuit numbers as indicated for panelboard connections. Comply with ampacity adjustment factors as required by the NEC Article 310.15.

P. General use circuit numbers may be changed. Update circuit directory.

Q. For multi-section panelboards, whether shown on the drawings or not, the Contractor shall provide interconnecting conductors from the feed-through lugs or feeder breaker in each section of the panelboard or distribution board to the incoming lugs of the second section, and from the feed-through lugs or feeder breaker second section to the incoming lugs of the third section, etc. The minimum size of the interconnecting conductors shall either match or exceed the physical size or ampacity of the first section’s incoming conductor size or shall meet or exceed the panelboard or distribution board’s ampere rating. For downstream sections of a panelboard that are supplied by a feeder breaker, the incoming conductor size shall be sized per the ampere rating of the overcurrent protective device supplying the feeder, unless noted otherwise on the drawings or in the written specifications.

R. Provide twelve-inches of slack cord, neatly coiled and bundled, for each cord drop and portable appliance connection as specified in this Section (2.2)(E).

S. Provide a separate dedicated circuit with neutral conductor for each branch-circuit that serves any of the following:

1) Computer loads.

2) Printers.

3) Copy machines.

4) Fax machines.

5) High intensity discharge lighting fixtures.

6) Other sensitive electronic loads.

7) Fire alarm control panel and power supplies.

8) Security control panel and power supplies.

9) Sound system equipment.

3.2 SPLICES AND TERMINATIONS:

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

B. All wire splices #6 and larger shall have UL Listed for submersible application type water proof insulating heat shrink type coverings, UL listed for 600 volt applications similar or approved equal to 3M ITCSN Heavy Wall shrink tubing. Covering shall be installed in accordance with the manufacturer's recommendations.

C. All junction boxes used for terminating or splicing wire that are in-grade, exterior to the building shall be filled with a re-enterable electrical insulating resin potting compound similar or approved equal to 3M Scotchcast # 2123. Resin shall not be installed until after all wire terminations have been made insulated and tested. Compound shall be installed in accordance with the manufacturer's recommendations.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Make splices and taps for conductors #6 and larger with permanent, straight or 'T' barrel compression type connectors. Compressions shall be made with compression tool intended for application with proper dies sized for connector and wire. Connector material shall match conductor.

F. 600 volt Switchboard, switchgear and panelboard main and feed-thru lugs plus switchboard or switchgear feeder breaker conductor connections shall use compression connectors. Compressions shall be made with compression tool intended for application with proper dies sized for connector and wire. Panelboard oversized back boards shall be provided to accommodate main and feed-thru compression connectors. Connector material shall match conductor. All main and feeder breaker wires shall use manufacturer provided compression lugs for bolting into breaker.

G. For multi-terminal (Polaris) type connectors, contractor shall distribute source and load conductors in accordance with UL 486A and UL 486B and manufacturer’s recommendations.

3.3 IDENTIFICATION:

A. Refer to Section 26 05 53, Electrical Identification, for identification requirements of 600 volt insulated conductors.

End of Section 26 05 19

SECTION 26 05 20 ELECTRICAL BOXES

1.0 GENERAL

1.1 SCOPE:

A. This section specifies the furnishing and installation of all outlet boxes, floor boxes, junction boxes and pull boxes.

1.2 REFERENCE STANDARDS:

A. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

B. UL 50 - Enclosures for Electrical Equipment.

C. UL 514A - Metallic Outlet Boxes.

D. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.

E. NECA 1-2000 - Standard Practices for Good Workmanship in Electrical Contracting (ANSI)

1.3 APPLICABLE PROVISIONS:

A. Refer to Section 26 05 00, Electrical General Provisions.

1.4 SUBMITTALS:

A. Submit manufacturer's technical product data on flush floor boxes only. Include data substantiating that materials comply with the requirements of this section.

1.5 DELIVERY, HANDLING AND STORAGE:

A. Deliver boxes and fittings in suitable containers.

B. Handling shall be done to ensure that boxes and fittings are not damaged in any way or cause damage to finishes.

C. Store boxes and fittings in suitable areas to prevent corrosion.

2.0 PRODUCTS

2.1 OUTLET BOXES:

A. For exposed device boxes, furnish FS or FD cast boxes for rigid metal conduit systems and galvanized steel boxes for EMT conduit systems.

B. For lighting fixtures, furnish 4" square with raised tile covers galvanized steel boxes, minimum 1-1/2 inch deep by 4 inch with accessories to properly support fixtures.

C. For masonry boxes, furnish rectangular galvanized steel boxes, minimum 3-1/2-inch deep by 3-3/4 inch high.

D. Galvanized boxes with larger than 3/4" raceway shall be 4 – 11/16" square and 2 – 1/8" deep minimum.

E. All metallic boxes are to have an internal means of grounding.

F. Within framed, drywall, plastered or tile covered walls, with ¾" max. raceway, furnish galvanized steel 4" square, minimum 1 ½" deep boxes with raised tile cover and a far-side support.

G. Within masonry walls, with ¾" max. raceway, furnish galvanized steel boxes, minimum 2 ½" deep.

2.2 FLUSH FLOOR BOXES:

A. Furnish concrete tight, corrosion resistant, fully adjustable, compartmental type for combination receptacle and communications type box, complete with duplex receptacle where indicated and hinged flooring insert cover plate unless otherwise noted on the drawings. Cover plate flanges shall be compatible with the finished floor. Color, material, and type of cover plate will be selected by Architect.

B. Floor box covers shall comply with the scrub water exclusion test requirements of UL for tile, terrazzo, wood and carpeted floors.

2.3 JUNCTION AND PULL BOXES:

A. Furnish galvanized code-gage sheet steel junction and pull boxes where shown on the drawings or where installation conditions warrant their use. Boxes shall be furnished with hinged covers. Size cover so that it can easily be handled by one person. All hardware and fasteners shall be galvanized.

B. Furnish NEMA 1 boxes in interior dry locations.

C. Furnish NEMA 3R boxes in all exterior locations and interior locations subject to moisture.

D. Furnish NEMA 4 cast iron boxes with external flush flanged cover when cast in concrete.

E. Furnish, minimum 4" square, 1 ½" deep, galvanized steel junction and pullboxes where installation conditions warrants their use.

2.4 UNDERGROUND BOXES:

A. U.L. listed.

B. Pre-cast, polymer concrete.

C. Minimum size of 10" W X 10" L X 10" H.

D. Bolt down cover.

E. Stainless steel hex-bolts and replaceable nuts.

F. Minimum load rating of 5,000 lbs (select by location).

3.0 EXECUTION

3.1 COORDINATION:

A. In order that all outlets may come in proper relation to paneling, decorated areas, etc., the Contractor shall familiarize himself with the details of these spaces and shall carefully lay out all outlets so that the equipment or piping of other trades passing under, over, across or in close proximity to same, will not cause the device or fixtures at or in these outlets to be inaccessible for use or maintenance. The Contractor must consult with the other Contractors on the project and procure all details of the various locations so as to make the outlet boxes come in proper relation to the work of all other trades. The Architect/Engineer reserves the right to have the Contractor relocate, at no cost to the Owner, any outlet a reasonable distance from its original location shown on the plans prior to the application of the walls at no cost.

B. Should outlets or receptacles be shown on the Engineering plans at the same location where the Architect shows enclosed cabinets or storage racks, Contractor shall notify the Architect prior to any installation and relocate the outlets or receptacles as directed.

3.2 OUTLET BOXES:

A. Unless otherwise indicated, install all outlet boxes flush with the finished wall or ceiling line. Install galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Securely fasten outlet boxes to framing. Provide additional cross bracing, bridging, and/or straps for boxes installed in stud type framing systems.

B. Boxes for suspended lighting fixtures shall not be attached to or supported from suspended ceilings, unless specifically approved by ceiling installer/manufacturer. Do not support boxes from ceiling suspension grid.

C. Do not connect outlet boxes back to back unless specific approval is obtained from the Architect/Engineer. Where such a connection is necessary to complete a particular installation, fill the voids between the boxes with sound insulating material.

D. Install only the conduit openings necessary to accommodate the conduits at the individual location. Install knockout closures to cap all unused openings.

E. Install weatherproof outlets and outlet boxes in areas subject to moisture with gaskets between the box and the cover plate.

F. All boxes shall be installed with cover plates.

G. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall.

H. Boxes to which light fixtures or pendants are mounted shall NOT contain any conductors foreign to the operation of such light or pendant application. Removal of lights, pendants and cord drops to access other branch circuits is NOT acceptable.

I. Raceways are NOT allowed to terminate to extension rings.

J. Install underground boxes with cover slightly above finished grade.

3.3 FLOOR BOXES:

A. Verify locations of all floor boxes with the Architect/Engineer before installation. Completely envelop floor boxes in concrete except at the top. Increase slab thickness at boxes if required for bottom covering. Adjust covers flush with finished floor.

3.4 JUNCTION AND PULL BOXES:

A. Install boxes as required to facilitate conductor installation in raceway systems. Junction and pull boxes shall be sized to accommodate conductor system splices and associated insulation. Generally install boxes in conduit runs of more than 100 feet or as required in Section 26 05 43, Raceways. Locate boxes strategically and make them of such shape to permit easy pulling of conductors.

B. Install boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above inaccessible ceilings. Select a practical size for each box and cover. All boxes shall have covers.

3.5 IDENTIFICATION:

A. Refer to Section 26 05 53, Electrical Identification, for the identification requirements of electrical boxes.

End of Section 26 05 20

SECTION 26 05 26 GROUNDING AND BONDING

1.0 GENERAL

1.1 SCOPE:

A. This section specifies the furnishing and installation of grounding and bonding equipment for electrical systems.

B. Section includes:

1) Grounding and bonding components.

2) Provide all components necessary to complete the grounding system(s) consisting of:

a. Metal underground water pipe.

b. Metal frame of the building.

c. Concrete-encased electrode.

d. Rod electrodes or plate electrodes.

e. Active electrodes.

f. Additional grounding electrodes and conductors as shown on the Drawings.

1.2 REFERENCE STANDARDS:

A. IEEE Std 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System.

B. IEEE Std 142 - IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

C. UL 83 - Thermoplastic-Insulated Wires and Cables.

D. UL 467 - Grounding and Bonding Equipment.

E. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

F. NECA 331 - Standard for Building and Service Entrance Grounding and Bonding.

G. IEEE C2 – Underground Component Grounding.

1.3 APPLICABLE PROVISIONS:

A. Refer to Section 26 05 00, Electrical General Provisions.

1.4 PERFORMANCE REQUIREMENTS:

A. Confirm measured ground resistances do not exceed the following values at each main grounding electrode bus bar:

1) Power and Lighting Equipment or System with less than 1000 kVA: 5 ohms.

2) Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

3) Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

4) Manhole Grounds: 5 ohms.

B. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

1.5 SUBMITTALS:

A. None required.

1.6 DELIVERY, HANDLING AND STORAGE:

A. Deliver grounding and bonding materials and accessories in suitable containers.

B. Handling shall be done to ensure that grounding and bonding materials and accessories are not damaged in any way or cause damage to finishes.

C. Store grounding and bonding materials and accessories in suitable areas to prevent corrosion.

2.0 PRODUCTS

2.1 GROUND COMPONENTS:

A. Furnish 5/8-inch by 8-foot long, copper-clad, steel grounding electrodes. Furnish rods to which the copper cladding is permanently and inseparably bonded to a high strength steel core.

B. Grounding Bus: Rectangular bars of annealed copper, ¼ x 4 inches in cross section, x 18 inches long, unless otherwise indicated; with insulators.

2.2 CONNECTIONS:

A. Listed and labeled by a nationally recognized testing laboratory acceptable to Authorities Having Jurisdiction for applications in which used, and for specific types, sizes and combinations of conductors and other items connected.

B. For below grade connections furnish exothermic welded type, unless otherwise noted for concealed, underground and concrete-encased ground connections. For above grade connections furnish bonds and clamps of a non-ferrous material which will not cause electrolytic action between the conductor and the connector.

2.3 BUSHINGS:

A. Furnish threaded malleable iron or steel insulated bushings with external lug for grounding conductor where metallic conduit containing ground conductors is used or plastic bushings for PVC conduit.

2.4 CONDUCTORS:

A. Furnish bare copper conductors for bonding jumpers. Furnish 600-volt insulated conductors having a green-colored insulation for grounding electrode and equipment grounding conductors. Furnish 600-volt insulated conductors having a green-colored insulation with a yellow stripe for isolated ground grounding conductors. Use solid conductors for 10 AWG wire; stranded for 8 AWG and larger.

2.5 GROUND ENHANCEMENT MATERIAL:

A. Furnish and install a low resistance carbon-based backfill material which will lower the grounding system resistance. Backfill materials containing bentonite or concrete components, or that require mixing in water prior to installation are not acceptable. Provide Harger “Ultrafill” or engineer approved equivalent.

2.6 ELECTRICAL ROOMS OR SPACES:

A. Furnish and install a ground bus bar at each service entrance equipment or switchboards, building transformers, uninterruptable power supplies (UPS), or other separately derived service.

2.7 COMMUNICATION ROOM BUS BAR:

A. Unless shown or specified larger on the technology drawings, provide and install a 1/4” x 4” x 18” copper surface mounted terminal block sufficient to accept 20 individual conductors of sizes 14 AWG thru 4 AWG in the following locations:

1) Each MDF and IDF room.

2) On each telephone board.

3) Where the television system terminations are located.

4) Others as specified in the Technology Contract Documents.

B. Terminate the grounding conductor to the ground bus and to the building electrical grounding system. Separate ground rods are not allowed.

3.0 EXECUTION

3.1 INSTALLATION:

A. All metallic conduits shall be electrically continuous.

B. Install flexible bonding jumpers in raceway system around expansion joints and for any isolated piping and ductwork.

C. Install grounding conductors in the shortest and straightest paths possible to minimize transient voltage rises. Unless shown otherwise on the drawings, provide and install a minimum 4/0 copper conductor between each satellite electrical room ground bus bar and main service ground bus bar as well as between the main service ground bus bar to each grounding electrode.

D. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed.

E. Install clamp-on connectors on clean metal contact surfaces to ensure electrical conductivity and circuit integrity.

F. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A to assure permanent and effective grounding.

G. Protect all exposed, grounding electrode conductors with Schedule 40 PVC nonmetallic conduit.

1) Grounding electrode conductors shall not be protected with metallic materials.

3.2 GROUNDING ELECTRODE:

A. Install a grounding electrode system for the service entrance equipment at the building. At each building's service or disconnecting means, install a bonding conductor between the service equipment ground and neutral bus. The grounding electrode system shall consist of the following:

1) The grounded service conductor at the service entrance equipment.

2) The building structural steel shall be grounded by means of a bonding jumper or conductor connected to the grounding electrode system. Provide a ground clamp to exposed steel member and connect to main service ground bus bar with 4/0 conductor.

3) The metal water pipe shall be bonded to the grounding electrode system. Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end. Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

4) Concrete encased electrode(s) shall be installed. Each electrode shall be installed per NEC Article 250.52(A)(3).

5) Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated. Provide ground enhancement material backfill around the driven ground rod per manufacturer's recommendations.

a. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

6) Ground plate: Bury a 24" x 12" x 1/4" copper ground plate a minimum of 24" below the finished grade or finished floor. Provide ground enhancement material backfill around the plate per the manufacturer's recommendations. The grounding electrode conductor shall be connected to the ground plate by an exothermic connection.

7) Provide a 1/4" x 12" x 24" copper plate electrode as specified above, buried not less than 30" below grade. The plate electrode shall comply with NEC Article 250.52 (A)(6). Plate shall be located adjacent to the point where the building service entrance conduits/lateral enters the building. Plate shall be connected back to the main building ground bus with a #4/0 copper grounding electrode conductor.

8) Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

9) Bond together reinforcing steel and metal accessories in any pool, fountain, and other water feature structures. Provide #2/0 ground conductor from accessories to main building ground bar.

10) Other electrodes shall be connected to the system as indicated on the drawings.

3.3 SYSTEM GROUND:

A. Where a system neutral is used, ground the system neutral conductor as required by NEC Article 250. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.

B. Ground neutrals of separately derived systems such as generators, transformers, etc., in accordance with NEC Article 250.30 as shown on the drawings.

C. Size the system grounding conductors to comply with NEC Table 250.66, unless indicated or shown larger.

3.4 SYSTEM BONDING:

A. Services.

1) Install a main bonding conductor between the main service ground bus and the grounded (neutral) bus bar.

B. Separately derived systems.

1) Install a bonding jumper between the main service system ground bus and each separately derived electrical system's (transformer, UPS, central battery/inverter or generator) grounded (XO-neutral) bus.

C. Grounding underground system components:

1) Grounding Manholes and Handholes: Contractor shall ground all utility equipment in accordance with utility standards. Where no standards exist or equipment belongs to the Owner, minimum grounding system shall consist of a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend

above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

2) Grounding Connections to Manhole Components: Contractor shall ground all utility equipment in accordance with utility standards. Where no standards exist or equipment belongs to the Owner, minimum grounding system shall consist of bonded exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductor's level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3) Exterior Pad-Mounted Transformers and Switches: Contractor shall ground all utility company transformers in accordance with utility standards. Where no standards exist or transformer belongs to the building Owner, minimum grounding system shall consist of two ground rods and ground ring around the pad. Ground pad-mounted equipment, slab rebar, and noncurrent-carrying metal items associated with transformer or meter arrangement by connecting them to underground cable and grounding electrodes. Install tinned-copper 4/0 conductor for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 ADDITIONAL BONDING:

A. Install 3/0 AWG bonding jumpers around all structural metal expansion joints.

B. Bond the grounded (XO-neutral) conductor of each separately derived system to the nearest available point of the ground bus bar service system.

C. Install bonding jumpers around raceway expansion joints.

D. Install bonding jumpers around insulated water pipe joints.

E. Install a bonding jumper between all grounding electrodes used for communications, radio and television or antenna systems and the building’s grounding electrode system.

F. Install ground grid under access floors. Construct grid of #2 AWG bare copper wire installed on 24 inch centers both ways. Bond each access floor pedestal to grid.

G. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #2 AWG bare copper conductor.

3.6 EQUIPMENT GROUND:

A. Raceways shall not be used as the sole equipment ground. Each feeder and branch circuit shall be provided with a green insulated copper grounding conductor. For existing installations, provide new conduit if required due to installation of new equipment grounding conductor. Adhere to conduit fill rates specified by the National Electrical Code.

B. Bond the equipment grounding conductors to all boxes and enclosures.

C. Each receptacle shall be bonded to its respective device box. The connection shall be made by means of a bonding jumper between the device and the box. Where the receptacle mounting yoke is designed and listed for the purpose of grounding; the bonding jumper may be omitted. This does not substitute for the need of grounding the outlet box.

D. Each isolated ground receptacle shall have an isolated ground conductor installed complete from receptacle to the isolated ground bus in the panelboard. No other grounding connections shall be made to these receptacles, specifically connections to the device box or raceway system.

End of Section 26 05 26

SECTION 26 05 29 HANGERS AND SUPPORTS

1.0 GENERAL

1.1 SCOPE:

A. This section specifies the furnishing and installation of metal framing, including channels, hangers, brackets, fittings, clamps, hardware, anchor bolts, rods, and electrical accessories for installing electrical equipment and materials.

1.2 REFERENCE STANDARDS:

A. AISI SG02-1- North American Specification for the Design of Cold-Formed Steel Structural Members.

B. ASTM A36 - Standard Specification for Carbon Structural Steel.

C. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

D. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

E. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.

F. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

G. ASTM A635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Commercial Steel, Drawing Steel, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, Hot Rolled.

H. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

I. ASTM A659 - Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot- Rolled.

J. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.

K. ASTM 1018 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.

L. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

M. ASTM B695 - Standard Specification for Coating of Zinc Mechanically Deposited on Iron and Steel.

N. ASTM F1136 - Standard Specification for Chromium/Zinc Corrosion Protective Coatings for Fasteners.

O. MFMA-3 - Metal Framing Standards Publication.

P. MFMA-102 - Guidelines for the Use of Metal Framing.

Q. NECA 1 - 2000 - Standard Practices for Good Workmanship in Electrical Contracting (ANSI)

1.3 APPLICABLE PROVISIONS:

A. Refer to Section 26 05 00, Electrical General Provisions.

1.4 SUBMITTALS:

A. None required.

1.5 DELIVERY, HANDLING AND STORAGE:

A. Deliver metal framing, fittings and accessories in suitable containers.

B. Handling shall be done to ensure that metal framing, fittings and accessories are not damaged in any way or cause damage to finishes.

C. Store metal framing, fittings and accessories in suitable areas to prevent corrosion.

2.0 PRODUCTS

2.1 MATERIALS:

A. Furnish channels, fittings, clamps, electrical accessories and brackets fabricated from sheet steel or from malleable cast iron. Furnish threaded fasteners fabricated from carbon steel.

2.2 COATINGS:

A. Hot-dip galvanize all steel components where directly exposed to weather or in crawl spaces.

B. Electro-galvanize all steel components.

2.3 SIZES:

A. Furnish channels fabricated from not less than 12-gauge sheet steel, 1-5/8 inches wide and not less than 1-1/2 inches deep for hangers supporting raceways. Furnish channels fabricated from not less than 12-gauge sheet steel, 1-5/8 inches wide and not less than 1-1/2 inches deep for anchoring vertical raceways to walls or when used to provide space between raceways or between raceways and walls or floors.

3.0 EXECUTION

3.1 INSTALLATION:

A. Install metal framing to support wall mounted or floor supported equipment and wall or ceiling mounted raceways. Where installed horizontally, metal framing shall be anchored to a minimum of two wall studs or two different masonry units using metallic anchors.

Where installed vertically, metal framing shall be anchored to a wall stud or two different masonry units using a minimum of two metallic anchors. Where installed on cast-in-place concrete tees or the web of pan joists, do not install anchors in the lower 6-inches of the tee or web.

B. All hangers, brackets, clamps, etc., shall be of standard weight steel. Perforated strap hangers shall not be used in any work. When two (2) or more conduits are run parallel, they may be supported on trapeze hangers, equal to the Modern Co. Other hangers shall be constructed with rods and hanger adjusters of adequate size to carry the loads imposed.

C. Unless otherwise shown on the drawings, all horizontal runs of conduit and piping shall be suspended from the floor or roof construction, as the case may be, by means of approved hangers placed not farther apart than ten (10) feet on centers. Vertical risers shall be supported by approved riser clamps or supports installed at the respective floor lines.

D. Supports and hangers shall be installed to permit free expansion and contraction in the raceway systems. Where necessary to control expansion and contraction, the raceways shall be guided and firmly anchored. Anchors shall be approved by the Engineer and shall be designed for equal effectiveness for both longitudinal and transverse thrust. No conduit shall be self-supporting, nor shall it be supported from equipment connections. Transmission of vibrations, noise, etc., shall be considered and any special suspension with vibration dampers to minimize transmission shall be used where necessary.

E. Where ducts interfere with the proper location of hangers, furnish and install trapeze hangers. Trapeze hangers may be used to support groups of conduit run in parallel.

F. Install metal framing to support wall mounted equipment and wall or ceiling mounted raceways.

G. Install expansion bolts to attach framing to concrete. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

3.2 ANCHOR BOLTS:

A. Install 1/2-inch diameter by 3 inch long expansion bolts to attach framing to concrete. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

3.3 TOUCH-UP:

A. Touch up all scratches or cuts on steel components with an approved zinc chromate or a 90 percent zinc paint.

End of Section 26 05 29

SECTION 26 05 43 RACEWAYS

1.0 GENERAL

1.1 SCOPE:

A. This section specifies the furnishing and installation of raceway systems.

1.2 REFERENCE STANDARDS:

A. ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated.

B. ANSI C80.3 - Electrical Metallic Tubing - Zinc-Coated.

C. NEMA FB 2.10 - Selection and Installation Guidelines for Fittings for Use with Non-flexible Electrical Metal Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit and Electrical Metallic Tubing).

D. NEMA FB 2.20 - Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable.

E. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.

F. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

G. UL 1 - Flexible Metal Conduit.

H. UL 5 - Surface Metal Raceways and Fittings.

I. UL 5A - Nonmetallic Surface Raceways and Fittings.

J. UL 6 - Electrical Rigid Metal Conduit - Steel.

K. UL 360 - Liquid-Tight Flexible Steel Conduit.

L. UL 467 - Grounding and Bonding Equipment.

M. UL 651 - Schedule 40 and 80 Rigid PVC Conduit.

N. UL 797 - Electrical Metallic Tubing - Steel.

O. UL 870 - Wireways, Auxiliary Gutters and Associated Fittings.

P. NECA 1-2000 - Standard Practices for Good Workmanship in Electrical Contracting (ANSI).

Q. NECA 101-2001 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).

R. NECA 111-2003 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) (ANSI)

1.3 APPLICABLE PROVISIONS:

A. Refer to Section 26 05 00, Electrical General Provisions.

1.4 SUBMITTALS:

A. None required.

1.5 DELIVERY, HANDLING AND STORAGE:

A. Deliver raceways and fittings in suitable containers.

B. Handling shall be done to ensure that raceways and fittings are not damaged in any way or cause damage to finishes.

C. Store raceways and fittings in suitable areas to prevent corrosion.

2.0 PRODUCTS

2.1 CONDUIT AND FITTINGS:

A. Rigid Metal Conduit.

1) Hot-dip galvanized rigid steel conduit, galvanized after fabrication. All threads shall be galvanized after cutting. A uniform zinc coating shall be applied to the inner and outer walls.

2) Fittings shall be threaded steel hot-dip galvanized with steel locknut plus nylon or thermoplastic bushing where conduit enters a box or panel.

B. PVC Coated Rigid Metal Conduit.

1) Conduit shall be rigid steel conduit with external PVC coating, 0.040-inch minimum, and comply with requirements listed in NEMA RN 1.

2) Fittings shall be threaded steel fittings with external PVC coating to match conduit and comply with requirements listed in NEMA FB 1.

C. Rigid Nonmetallic Conduit.

1) PVC: Schedules 40 or 80 rated for use with 90º C. conductors, UL Labeled and Listed 651 (Conduits), 514b (Fittings) and complying with NEMA Specification TC-2 (Conduit), TC-3 (Fittings).

2) PVC compound shall be made with inert modifiers to improve weather ability and heat distortion. Installed conduit and fittings shall be homogeneous plastic free from visible cracks holes or foreign inclusions, smooth and free of blisters, nicks or other imperfections either interior or exterior to the conduit. Conduit fittings and cement shall be from the same manufacturer to insure system integrity. UL stamp shall be visible on conduit sections.

D. Intermediate Metal Conduit (IMC).

1) Conduit shall be similar to rigid steel conduit except thinner wall.

2) Fittings shall be threaded steel hot-dip galvanized with steel locknut plus nylon or thermoplastic bushing where conduit enters a box or panel.

E. Electrical Metallic Tubing (EMT).

1) EMT shall be made of hot-dip galvanized steel.

2) Fittings shall be steel, electro zinc plated. Provide steel threaded locknut where connection enters a box or panel with nylon or thermoplastic insulator. Connectors shall be steel set screw or compression type when used interior to a conditioned building. Combination UL Listed rain/concrete tight compression connectors shall be used where exposed, encased in concrete or placed in non-conditioned interior spaces.

F. Flexible Metal Conduit (FMC).

1) Spirally wound continuously interlocked zinc coated strip steel.

2) Fittings shall be listed for FMC usage. Fittings shall be steel, electro zinc plated with screwed wedge to hold cable in place. See T & B series #3100 for basis of design. Provide thermoplastic or nylon insulated busing where cable enters a box or panel.

G. Liquid-Tight Flexible Metal Conduit (LFMC).

1) Spirally wound continuously interlocked zinc coated strip steel with a UV stabilized polyvinyl chloride (PVC) outer jacket bonded to the conduit. LFMC shall be UL Listed with ground conductor.

2) Fittings shall be compression water tight type, galvanized zinc plated steel including body, gland and locknut. Sealing gasket shall be provided. Provide nylon or thermoplastic insulated bushing where conduit enters a box or panel.

H. Metal Clad Cable (MC).

1) Galvanized interlocking steel armor.

2) 600 volt, type THWN-2, integrally colored insulation.

3) Copper conductors.

4) Fittings shall be listed for MC usage. Fittings shall be steel, electro zinc plated with screwed wedge to hold cable in place. See T & B series #3100 for basic of design. Provide thermoplastic or nylon insulated bushing were cable enters a box or panel.

I. Metal Wire-ways.

1) Furnish with wire retainers on not less than 12 inch centers. All screws installed towards inside shall be protected to prevent possible wire insulation damage.

2) The finish shall be the manufacturers' standard color and shall consist of not less than two coats of enamel over a rust-inhibiting prime coat.

J. Surface Metal Raceway (2000 series).

1) Surface metal raceway shall consist of a single compartment base, blank cover, and appropriate fittings to complete the installation per the electrical drawings.

2) The base and cover shall be manufactured of steel and finished with an ivory color.

3) Approximately ¾" deep, 1 ¼" high and 5' sections.

K. Non-Metallic Multi-outlet Assemblies (5400 series).

1) Surface raceway system shall consist of a dual compartment raceway base, twin cover, appropriate fittings, outlets and device mounting plates necessary for a complete installation.

a. Wiremold 5400-TB base (8" standard length).

b. Wiremold 5400-TC cover (8' standard length).

2) Duplex receptacles and data outlets ("activate connectivity inserts") mounted at 24" centers or as noted on plans. Connect adjacent receptacles on alternate circuits.

a. Wire mold 5450 power and communication device bracket.

b. Wiremold CM-EPLA end plate.

c. Wiremold 5507D duplex cover.

d. Wiremold 5507FRJ dual RJ11 or RJ45 cover.

3) Approximately 1 ¾" deep, 5 ¼" high and 8' sections with equal compartments.

3.0 EXECUTION

3.1 CONDUIT AND FITTINGS:

A. Types According to Use.

1) Use rigid metal conduit where exposed and installed less than 96 inches above finished floor or where exposed to rain, condensation, moisture or corrosive atmosphere and where installed encased in concrete or below grade underneath the building slab. Additionally, use where conduit runs from below grade level and shall transition to galvanized rigid metal conduit (RMC) or intermediate steel conduit (IMC), wrapped with corrosion protection tape, prior to exiting at grade level and continue thereafter. Where rigid metal conduit exits into concrete, caulk concrete-to-conduit joints with a silicone rubber compound. Also use RMC exposed to a height of 96" in an electrical or mechanical room. Finally, use RMC when inside and exposed less than one foot above a finished attic floor or mezzanine floor. In exterior locations, use RMC less than 10 feet above the finished floor or less than one foot above the finished ground surface within a lockable equipment yard. Use malleable iron straps when are required at these exterior locations. Minimum size of RMC or IMC is ¾" when located outside the building line, below a concrete slab, located below a beam of a slab-on-grade, or located within a concrete slab-on-grade where the outside diameter is equal to or less than 20 percent of the slab thickness. Seal conduit ends at each building entry. Below grade, the minimum size shall be ¾ inch.

2) Use electrical metallic tubing in interior walls or ceiling spaces and where exposed when installed more than 96 inches above finished floor in open work areas, or above 96 inches in mechanical rooms, or electrical rooms. Do not use in the mortar-filled cells of concrete masonry units. Conduit which enters or leaves the top of panelboards or enclosures may be EMT, provided the top of the panelboard or enclosure is a minimum of 60 inches above finished floor. Electrical metallic tubing shall not be installed in concrete or in contact with earth. Additionally, use electrical metallic tubing inside when exposed and more than one foot above a finished attic or mezzanine floor. Use electrical metallic tubing inside when more than 10 feet above the finished ground surface or more than one foot above the finished ground surface within a lockable equipment yard. Finally, use electrical metallic tubing outside in the crawl space with the first level elevated.

3) Rigid nonmetallic conduit may be used in lieu of rigid metal conduit for underground branch circuits and feeders outside of the building line as permitted by the NEC and local codes. All vertical transitions in rigid nonmetallic conduit shall be made using galvanized rigid steel elbows. Rigid nonmetallic conduit may be installed in concrete slab on grade construction where the nominal trade size diameter is equal to or less than 20 percent of the minimum slab thickness when allowed by the Structural Engineer. Rigid nonmetallic conduit shall not be installed in elevated floor slabs or within the building envelope. Also, use as protection for exposed grounding electrode or bonding conductor below 10 feet to guard from physical damage.

4) Flexible metal conduit (FMC) may be used in dry, interior locations with a minimum length of two feet and a maximum length of six feet as the final connection to transformers, motors and vibrating equipment. Also, use FMC to connect to ceiling mounted outlet boxes or recessed light fixtures.

5) Metal-clad cable may be used in lieu of flexible metal conduit as long as it's used in concealed and dry locations. Metal clad cable shall be used for single pole, three wire (phase, neutral and ground) branch circuits only supplied from maximum 40 AMP breakers. Metal clad cable shall be routed parallel or perpendicular to building walls. All cable shall be neatly packed and supported on steel channel trapeze hangers with individual clamps. Channels shall be no more than 10' on centers. Metal clad cable use shall be approved by the local authority prior to any installation.

6) Liquid-tight flexible metal conduit can be used in all locations with a minimum length of 2 feet and a maximum length of six feet, the final connection to all liquid pump motors and associated control connections, damp or wet interior and all exterior locations with a minimum of two feet and a maximum of 6 feet, and the final connections to transformers, motors and vibrating equipment.

7) Schedule 40 rigid non-metallic conduit (PVC) may be used in exterior locations, where installed within concrete encasement such as a building slab or duct bank, in crawl space(s), and where otherwise explicitly allowed by these specifications. For all installations, provide galvanized steel rigid metallic elbows with long radius sweeps.

B. Transitions.

1) Continue the heavier, more protective type conduit application not less than 4 inches into the area where lighter, less protective type conduit is permitted.

2) For below-grade to above-grade outdoor locations, extend concrete encasement around conduit 4-inches above finished grade and slope top away from conduit with a 6-inch-per-foot slope. After concrete has set, caulk the concrete-to-conduit joint with a silicone rubber compound.

3) All non-metallic conduit runs concrete encased or from below grade level shall transition to galvanized rigid or intermediate steel wrapped with corrosion protection tape, prior to exiting grade. Rigid or intermediate steel conduit shall extend a minimum 12" below and above grade then continue as specified.

C. Install sleeves in the forms of walls and floor slabs for the installation of raceways. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls.

D. Installation Requirements.

1) Comply with NECA 1 or NECA 101 for installation requirements.

2) Install rigid metal conduit (RMC) per NEC Article 344, electrical metallic tubing (EMT) per NEC Article 358, rigid non-metallic conduit (RNC) per NEC article 352, flexible metal conduit (FMC) per NEC Article 348 and liquid-tight flexible metal conduit (LFMC) per NEC Article 350.

3) Install raceway systems to comply with Drawings and specification requirements, complete with all junction and pull boxes as necessary. It is the Contractor's responsibility to locate and size all J-boxes, pull boxes or gutters as required by code or as necessary for ease of installation.

4) Install raceways perpendicular and parallel to the building lines in a neat and orderly manner.

5) Install raceways concealed in all finished areas unless otherwise specifically indicated on the Drawings. When exposed the exact routing shall be confirmed in the field with the Architect/Engineer prior to rough-in. Install chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select plates to properly fit the conduit and securely lock in place.

6) Metallic raceways shall be continuous between enclosures and boxes. The raceway shall be secured to enclosures and boxes so that the raceway system is electrically continuous throughout.

7) Rigid nonmetallic conduit shall be solvent welded at the joints to form a tight, waterproof connection. Direct buried RGS conduit shall be wrapped in waterproof PVC tape or epoxy painted. Tape shall overlap a minimum ¼".

8) No wiring systems of any type shall be installed in ducts used to transport dust, loose stock, or flammable vapors.

9) No wiring system of any type shall be installed in any shaft containing ducts used for vapor removal or for ventilation of commercial-type cooking equipment.

10) Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

11) Arrange stub-ups so curved portions of bends are not visible above the finished slab.

12) Install no more than the equivalent of three 90-degree bends in any conduit run.

13) Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed epoxy paint compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

14) Exposed conduit in any and all exterior canopies, overhangs, covered areas, etc. is not allowed. Conduit routed in any of these areas shall be concealed – no exceptions. Should exposed conduit in any of these areas be installed, the Contractor shall re-route the conduit in a concealed location suitable to the Owner at no cost. The Contractor shall also repair and refinish, to the condition the surface was prior to the conduit re-routing, any and all building finishes that may be necessary to accommodate the concealed route (i.e. repair and refinish/texture drywall, etc.). No additional time or money will be allowed for this work.

E. Installation Methods.

1) Raceway systems shall be complete before installing conductors.

2) Raceways shall have openings temporarily plugged to exclude foreign objects. The interior of all raceways shall be cleaned before installing conductors.

3) Joints shall be cut square and be reamed smooth. Field threaded raceways shall be coated with an approved zinc chromate or with a 90 percent zinc paint.

4) Bends shall be made with standard ells or conduit field bent to radii in accordance with the NEC. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1-inch may be used only where specifically approved by the Architect/Engineer. Field bends shall be made using equipment designed for the particular raceway material and size. Bends shall be free from dents or flattening

5) Securely fasten and support raceway to structure or metal framing using malleable iron pipe straps or other approved means. Branch circuit raceways 1 inch and smaller may be attached to wall studs. Wires of any type for securing raceways are not acceptable. Raceways shall not be supported from suspended ceiling suspension system.

6) Install a flat, woven polyester pulling line, minimum 1800-pound tensile strength, in all empty raceways. Identify both ends of the line by means of labels or tags reading "Pulling Line."

7) Install expansion-deflection fittings where raceways cross structural expansion joints or where required to compensate for thermal expansion and contraction. Install bonding jumpers across fittings in metal raceway systems.

8) Terminate concealed raceways for future use with a coupling set flush with the structural surface. Install an approved plug flush with the surface.

9) All openings around electrical penetrations at fire rated walls, or sound-resistant-rated partitions, floors or ceilings shall be sealed to maintain the fire resistance rating of the penetration.

10) Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

    b. Within hazardous locations.

    c. Where otherwise required by NFPA 70.

11) Ceiling system wires or lay-in type ceiling grid components shall not be used as a means of support.

    a. Independent support wires and associated fittings which are installed in addition to the ceiling system support wires shall be permitted.

    b. Independent wires within the cavity of a fire-rated floor-ceiling or roof-ceiling assembly shall be distinguishable by color. (300-11.A).

    c. Independent support wires that provide support for device boxes shall be secured at both ends. (300.11.A)

12) Minimize roof penetrations by routing conduit through the equipment roof opening. If roof penetration is necessary, coordinate with the Architectural Specifications and penetrate as directly below the equipment disconnect or wiring connection point as possible. Do not use flexible conduit in a pitch pan.

13) Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

14) All fittings terminating in panels or junction boxes shall be provided with plastic inserts or insulated bushings or throats to reduce stripping off of insulation when pulled. Inserts and throats shall not impede electrical bonding and grounding between raceways or between raceway and panel or junction box. All metal raceways including junction/pull boxes, panels or other utilization equipment shall be electrically continuous and grounded.

15) For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the type indicated

16) Provide expansion fittings for all conduit systems as recommended by the manufacturer but no greater than 100' or longer between fittings including concrete encased PVC duct banks.

3.2 INSTALLATION OF UNDERGROUND RACEWAYS:

A. Install raceway a minimum of 18 inches below finished grade to top of the raceway or as shown on drawings.

B. Excavate trenches to the proper width and depth for the installation of the underground raceways. All trenching shall be done in accordance with OSHA requirements.

C. Where the bottom of the trench is excavated below the necessary elevation, it shall be brought to proper grade by the use of sand or pea gravel.

D. Where unstable ground is encountered in the bottom of the trench, it shall be excavated to a depth of at least 12 inches below the burial depth of the raceways, and replaced with coarse gravel to the proper height.

E. Where the excavation for its entire depth is in water or wet sand, slope or pump trench so as to drain it effectively.

F. Level and compact the bottom of the trench before installing a 4" minimum sand bed. Install the raceways and backfill over raceways with another 4" of sand. Backfill the remainder of the trench with the excavated material unless otherwise specified. Backfill shall be thoroughly compacted to 95 percent density of surrounding undisturbed soil. Sodded areas shall be compacted to 95 percent density up to topsoil layer. Topsoil layer shall be lightly compacted, and then soil mounded to allow for settling.

G. Where raceways are to be installed under existing sidewalks, roads or curbs, saw cut and remove same in order to install the raceways. All sidewalks, roads or curbs shall be replaced with material equivalent to those now in place.

H. Raceways required to be concrete encased shall be installed on nonmetallic spacers to allow a minimum of 3 inches encasement on all sides a minimum of 2 inches between parallel runs of raceways. Care shall be taken to prevent movement of raceways during pouring. Concrete shall be 2500 PSI, 28 day compressive strength.

I. A #10 AWG tracer wire shall be installed in all trenches which do not contain conductive conductors within them. This will include future use raceways, optical fiber, etc.

3.3 EMERGENCY SYSTEM RACEWAY:

A. Wiring classified as Emergency and Essential (Life Safety, Critical and Essential Equipment) supplied from either the utility normal or generator supported distribution system, shall be kept entirely independent of all other wiring, raceways or other equipment. All emergency system raceways including conduit, junction boxes and pull boxes shall be kept separate from all normal power feeders and branch circuits. Common junction boxes shall not be used for pulling or terminating both normal and emergency feeders.

B. Emergency wiring circuits shall be installed so as to minimize the hazards that might cause failure due to flooding, fire, icing, vandalism, and other adverse conditions.

C. Emergency Feeder-Circuit raceways shall be installed in areas fully protected by a automatic fire suppression system, or protected by a listed thermal barrier, or installed in a minimum 1 hour listed assembly, or embedded in not less than 2 inches of concrete, or be a cable UL listed for a minimum 1 hour fire rated integrity when installed in accordance with the listing requirements.

End of Section 26 05 43

SECTION 26 05 53 ELECTRICAL IDENTIFICATION

1.0 GENERAL

1.1 SCOPE:

A. This section specifies the furnishing and installation of products for the identification of electrical materials and equipment.

1.2 REFERENCE STANDARDS:

A. NFPA 70 - National Electrical Code.

B. OSHA - Occupational Safety and Health Act.

1.3 APPLICABLE PROVISIONS:

A. Refer to Section 26 05 00, Electrical General Provisions.

1.4 SUBMITTALS:

A. None required.

1.5 DELIVERY, HANDLING AND STORAGE:

A. Deliver electrical identification materials and accessories in suitable containers.

B. Handling shall be done to ensure that electrical identification materials and accessories are not damaged in any way or cause damage to finishes.

C. Store electrical identification materials in suitable areas to prevent corrosion.

2.0 PRODUCTS

2.1 COLORED TAPE:

A. Furnish Scotch No. 35 or approved equivalent 7-mil thick by 3/4" wide vinyl adhesive tape for color coding.

2.2 PLASTIC NAMEPLATES:

A. Furnish engraved black-white-black plastic laminate nameplates for identification of normal service equipment and red-white-red plastic laminate for identification of emergency service equipment. Edges of nameplates shall be chamfered.

3.0 EXECUTION

3.1 INSTALLATION:

A. Install identification products as required by the NEC and OSHA and elsewhere where required by this section.

B. Install identification products in accordance with manufacturer's written instructions.

C. Where identification is to be applied to surfaces that require a field finish, install identification after completion of the finish work.

3.2 UNDERGROUND RACEWAYS:

A. Install underground installation marking tape 6 to 12 inches below grade directly over all underground raceways that are exterior to the building.

1) Warning tape over electrical installations under 600 volts shall be red with black lettering stating "ELECTRIC LINE BURIED BELOW".

2) Warning tape over communications installations shall be orange with black lettering stating "TELEPHONE LINE BURIED BELOW".

3) Warning tape over cable television installations shall be orange with black lettering stating "CABLE TV LINE BURIED BELOW".

3.3 OUTLET, JUNCTION AND PULL BOXES:

A. Label outlet box covers using a black permanent marking pen with the identity of the circuits contained within the box.

B. Paint all boxes for fire alarm system red.

3.4 INSULATED CONDUCTORS:

A. Color code all 600 volt insulated conductors by installing conductors with factory colored insulation for conductors 10 AWG and smaller in accordance with the table in Paragraph C. below.

B. Install colored tape on all 600 volt conductors 8 AWG and larger in accordance with the table in paragraph C. below. Apply tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Do not cover factory applied cable identification markings with taping; tape locations may be adjusted slightly to prevent the covering of factory markings.

C. Color code conductors in accordance with the table below or as required by local codes, if different from the color scheme indicated. Install a permanently adhered label in the interior of each panelboard with the color coding used on the project.

Phase	480Y/277	208Y/120	240Δ/120	240Δ	120/240
A or L1	Brown	Red	Red	Red	Red
B or L2	Yellow	Black	Black	Orange	Black
C or L3	Purple	Blue	Orange	Blue	- - -
Neutral	Gray	White	White	- - -	White
Neutral for IG or TVSS circuits	- - -	White with tracer to match phase color	- - -	- - -	- - -
Switch Leg and Travellers	Match phase color	Match phase color	Match phase color	Match phase color	Match phase color

Phase	480Y/277	208Y/120	240Δ/120	240Δ	120/240
Ground	Green	Green	Green	Green	Green
Isolated Ground	- - -	Green with yellow tracer	Green with yellow tracer	- - -	Green with yellow tracer

3.5 EQUIPMENT:

A. Install engraved plastic laminate nameplates as listed below.

Equipment	Text Size	Information and Examples
Overcurrent devices serving the MDF panel	1/8”	Install nameplate adjacent to the overcurrent device. EX: Critical Load, MDF Power Source
LOW VOLTAGE SWITCHBOARDS Name Ratings Devices	 1/4" 1/8" 1/8"	Switchboard designation/ampere and voltage ratings/ load served SWITCHBOARD SBA, SBB, SBC 4000A 480Y/277V All devices fed from switchboards.
PANELBOARDS Name Ratings	 1/4" 1/8"	Panelboard designation/ampere and voltage ratings PANEL XXX where XXX is panel from one-line diagram. XXX A Y/YYYV where XXX is 3 phase voltage and YYY is single phase voltage.
TRANSFORMERS	1/8"	Load served and circuit number PANEL XXX where XXX is panel transformer served. CKT YYY where YYY is panel name and circuit serving transformer primary.
SAFETY SWITCHES	1/8"	Load served and circuit number ELEVATOR NO. 1 CKT 1LB3 -37,39,41
MOTOR STARTERS	1/8"	Load served and circuit number AHU-1 CKT 1LB3-38,40, 42
TIME SWITCHES	1/8"	Load served Exterior lights
CONTACTORS	1/8"	Load served Exterior Lights
POWER RECEPTACLES	1/8”	Panel name and circuit number LB3-21

B. Install nameplates labels in locations on the equipment for best convenience of viewing without interfering with the operation and maintenance of equipment. Install “Critical Load” nameplates adjacent to the overcurrent devices. Secure nameplate to equipment by means of stainless steel self-tapping machine screws. Exercise care to ensure that screws do not contact, damage, or puncture any portion of the equipment/device, conductor, bus, etc.

3.6 PANELBOARDS DIRECTORY AND EMERGENCY LIGHTING:

A. Prepare a neatly typed panelboard circuit directory. Identify all circuits by the equipment served and by the room number, room numbers may be different from those shown on drawings. Indicate spares and spaces with light, erasable pencil marking.

B. Label box covers using black marking pen with the identity of the circuits contained within the box.

C. Label emergency and exit lighting power packs, using black marking pen, with the identity of the un-switched circuit.

End of Section 26 05 53

SECTION 26 28 13 FUSES - 600 VOLT AND BELOW

1.0 GENERAL

1.1 SCOPE:

A. This section specifies the furnishing and installation of fuses rated 600 volts and below, 6000 amperes and below.

1.2 REFERENCE STANDARDS:

A. NEMA FU 1 - Low Voltage Cartridge Fuses.

B. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.

C. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.

D. UL 248-9 - Low-Voltage Fuses - Part 9: Class K Fuses.

E. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses.

F. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.3 APPLICABLE PROVISIONS:

A. Refer to Section 26 05 00, Electrical General Provisions.

1.4 SUBMITTALS:

A. Submit manufacturer's technical product data on fuses. Include data substantiating that materials comply with the requirements of this section.

1.5 DELIVERY, HANDLING AND STORAGE:

A. Deliver fuses in suitable containers.

B. Handling shall be done to ensure that fuses are not damaged in any way.

C. Store fuses in suitable areas to prevent damage.

D. Furnish one, steel, primed, and painted, lockable fuse cabinet with two shelves and an inventory card. The approximate dimensions shall be 30” H x 24” W x 12” D.

1.6 OPERATING AND MAINTENANCE DATA:

A. Submit manufacturer's standard operating and maintenance data/manuals.

2.0 PRODUCTS

2.1 VOLTAGE:

A. Furnish fuses with voltage ratings suitable for the nominal voltage of the system in which they are to be applied.

2.2 TYPES:

A. Furnish UL Class RK-5 for 600 ampere and smaller or UL Class L for 601-6000 ampere time delay, current limiting fuses having 200,000 rms symmetrical ampere interrupting rating. Use on all circuits supplying motors and transformers, and where otherwise indicated.

B. Furnish UL Class CC time delay, current limiting fuses having 200,000 rms symmetrical ampere interrupting rating. Use on all control power transformers.

C. In-line, type KTK, fuse holders shall be:

1) 600 volt rated.

2) Single pole for 120 or 277 volt circuits and double pole for 208 or 480 volt circuits.

3) Copper, set-screw terminal type with 2 line-side and 1 load-side connections.

4) Provide line and load insulating boots for each conductor.

5) Bussmann type HEB and HEY series or equal.

2.3 MANUFACTURER:

A. All low voltage fuses must be the product of a single manufacturer.

2.4 ACCEPTABLE MANUFACTURERS:

A. Bussman, Gould (Shawmut), Littlefuse.

3.0 EXECUTION

3.1 INSTALLATION:

A. Follow the manufacturer's installation instructions.

B. Check fasteners on fuse clips for tightness when installing fuses.

C. Install fuses so label is in an upright, readable position. Fuses without labels are not acceptable.

D. Fuse sizes as recommended by equipment manufacturer shall take precedence over sizes shown on the drawings.

E. Install an in-line fuse holder, with type KTK fuses(s), at each light pole’s hand hole to protect the branch circuits(s) extension up the pole. Fuses located at or on the fixture are NOT acceptable.

3.2 SPARE FUSES:

A. As spares, furnish the greater amount of either two of each fuse size and type installed or 10 percent of each fuse size and type installed. Place spare fuses in the fuse cabinet.

End of Section 26 28 13

SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

1.0 GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.2 SUMMARY:

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1) Fusible switches.

2) Nonfusible switches.

3) Bolted-pressure contact switches.

4) High-pressure, butt-type contact switches.

5) Molded-case circuit breakers.

6) Molded-case switches.

7) Enclosures.

1.3 DEFINITIONS:

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. HD: Heavy duty.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 SUBMITTALS:

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1) Enclosure types and details for types other than NEMA 250, Type 1.

2) Current and voltage ratings.

3) Short-circuit current rating.

4) UL listing for installed devices.

5) Features, characteristics, ratings, and factory settings of individual over-current protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

1.5 QUALITY ASSURANCE:

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1) Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Contractor shall provide shop drawings indicating dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with allowed space.

1.6 PROJECT CONDITIONS:

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1) Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2) Altitude: Not exceeding 5000 ft.

1.7 COORDINATION:

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Service Entrance: Fused Switches or enclosed breakers shall be listed for ‘Service Entrance’ duty when used at utility or building/structure/retail main service points. Contractor shall provide listed devices with any required accessories as necessary.

C. Size. The physical size and configuration of the enclosed switch and/or circuit breaker may be varied to suit the manufacturer's standard design, provided the intended functions are accomplished and the proposed equipment will physically fit within the space allotted in the floor plans. Any change in size or configuration must be noted on the submittal.

1.8 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1) Spares: For the following:

a. Potential Transformer Fuses: Two (2) for each type provided.

b. Control-Power Fuses: Two (2) for each type provided.

c. Fuses and Fusible Devices for Fused Circuit Breakers: Two (2) for each type provided.

d. Fuses for Fusible Switches: Two (2) for each type provided.

e. Fuses for Fused Power Circuit Devices: Two (2) for each type provided.

2) Spare Indicating Lights: Two (2) for each type provided.

2.0 PRODUCTS:

2.1 FUSIBLE AND NONFUSIBLE SWITCHES:

A. All safety switches shall be heavy-duty type with an ampere and horsepower rating meeting or exceeding the requirements of the actual motors furnished and complying with the minimum rating requirements of the NEC. The safety switch horsepower rating shall meet or exceed the horsepower rating that corresponds to the sum of all locked-rotor currents (that may be started simultaneously) on each motor circuit. Switches shall be rated 600Vac for use on the 480-volt system and 250Vac for use on the 208-volt system.

B. Fusible Switch, 800A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 800A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1) Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2) Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.

3) Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.2 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES:

A. Molded-Case Circuit Breakers shall be as follows:

1) UL 489 listed, with interrupting capacity to meet available fault currents.

2) Provide as shown below unless indicated otherwise on the drawings.

a. Up to and including 150 ampere frame sizes shall be non-adjustable, fixed inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.

b. Over 150 ampere up to and including 400 ampere frame sizes shall be equipped with digital solid-state RMS sensing trip units and adjustable instantaneous trips.

c. Over 400 ampere frame sizes shall be 100% rated, have digital solid state RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

i. Instantaneous trip pickup.

ii. Long- and short-time pickup levels.

iii. Long- and short-time delay adjustments.

iv. Ground-fault (where required by NEC or indicated) pickup level, time delay and I^2t response.

3) Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door as shown on the drawings.

4) GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

5) GFEP Circuit Breaker: Single- and two-pole configurations with 30-mA trip scensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories:

1) Standard frame sizes, trip ratings, and number of poles.

2) Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.

3) Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

4) Ground-Fault Protection (when shown on the drawings or required by the AHJ, NEC or other governing Code): Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

5) Shunt Trip (when shown on the drawings or required by the AHJ, NEC, or other governing Code): 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

6) Undervoltage Trip (when shown on the drawings): Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

7) Pad lock ‘off’ capability (when shown on the drawings or when the circuit breaker serves a piece of equipment without a local disconnecting means or required by the AHJ, NEC, or other governing Code): Breaker enclosure shall be provided with permanent, non-removable provisions to lock circuit breaker in the off position.

8) Branch circuit breakers supplying receptacles, outlets and junction boxes for lighting or other equipment in dwelling units shall be Arc-Fault Circuit Interrupter (AFCI) rated in compliance with NEC and UL 1699.

C. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

2.3 ENCLOSURES:

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1) Outdoor Locations: NEMA 250, Type 3R.

2) Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

3) Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.3 ACCEPTABLE MANUFACTURERS:

A. Basis of design manufacturer shall be Eaton Electrical/Cutler-Hammer. Should contractor select other than basis of design it will be their responsibility to coordinate all physical size, performance or other operational requirements and provide all options and accessories as specified herein. Other acceptable manufacturers include:

1) Eaton Electrical/Cutler-Hammer: www.eatonelectrical.com.

2) GE Industrial: www.geindustrial.com.

3) Square ‘D’ / Schneider Electric: www.squared.com.

4) Substitutions: Not permitted.

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting or exceeding all requirements listed in the construction documents in their entirety.

3.0 EXECUTION

3.1 EXAMINATION:

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES:

A. Coordinate size and location of concrete bases. Refer to specification Section 26 05 00, Electrical General Provisions. Contractor shall refer to the structural engineering documents for all housekeeping pad structural requirements, including, but not limited to: rebar or other reinforcements, concrete strength, etc.

3.3 INSTALLATION:

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Refer to specification Section 26 05 53, Electrical Identification, for additional information. Anchor floor-mounting switches to concrete base.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install the fuses as specified in the Contract Documents. Refer to specification Section 26 28 13, Fuses 600 Volt and Below. Paralleling of fuses per phase is not acceptable.

3.4 IDENTIFICATION:

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26, Section 26 05 53, Electrical Identification.

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26, Section 26 05 53, Electrical Identification.

3.5 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Prepare for acceptance testing as follows:

1) Inspect mechanical and electrical connections.

2) Verify switch and relay type and labeling verification.

3) Verify rating of installed fuses.

4) Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1) Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2) Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3) Infrared Scanning:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each

enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.

b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.

c. Instruments, Equipment and Reports:

4) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 ADJUSTING:

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING:

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

End of Section 26 28 16