PROJECT SPECIFICATION MANUAL

Houston Community College – Central Administration Building
3100 Main Street, Houston, TX 77002

AHU VFD and Control System Replacement

Prepared for:

Houston Community College
3100 Main Street
Houston, Texas 77002

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Engineering Services Provided By:

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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 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 09 13 VARIABLE FREQUENCY DRIVES

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 solid-state, PWM, VFDs for speed control of a standard NEMA Design B induction motor operating an HVAC-service fan, blower, or pump.

1.3 DEFINITIONS:

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFD: Variable frequency drive.

1.4 SUBMITTALS:

A. Product Data: For each type of VFD, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD.

1) Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.

b. Nameplate legends.

c. Short-circuit current ratings of integrated unit.

d. UL listing for series rating of overcurrent protective devices in combination controllers.

e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2) Wiring Diagrams: Power, signal, and control wiring for VFD. Provide schematic wiring diagram for each type of VFD.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD layout and relationships between electrical components and

adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency and manufacturer.

E. Field Test Reports: Written reports specified in Part 3.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals.

1) Routine maintenance requirements for VFDs and all installed components.

2) Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated dimensions and clearances.

F. VFDs and options shall be UL508 listed as a complete assembly.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Deliver VFDs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 COORDINATION:

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

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) Spare Fuses: Furnish one spare for every five installed, but not less than one set of three of each type and rating.

2.0 PRODUCTS

2.1 MANUFACTURERS:

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

1) ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.

2) Yaskawa, Inc.

2.2 VARIABLE FREQUENCY DRIVES:

A. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

B. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

C. Unit Operating Requirements:

1) Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.

2) Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.

3) Capable of driving full load, under the following conditions, without derating:

a. Ambient Temperature: 0 to 40 degrees C. (32 to 104 degrees F.)

b. Humidity: Less than 90 percent (non-condensing).

c. Altitude: 0 to 3300 feet (1000 m) above sea level.

d. Minimum Efficiency: 96 percent at 60 Hz, full load.

4) Minimum Displacement Primary-Side Power Factor: 96 percent.

5) Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.

6) Starting Torque: 100 percent of rated torque or as indicated.

7) Speed Regulation: Plus or minus 1 percent.

D. Self-Protection and Reliability Features:

1) Built-in 5% line impedance for input harmonic reduction and to add protection from AC line transients.

2) All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level

3) Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.

4) Motor Overload Relay: Adjustable and capable of NEMA 250, Class 20 performance.

5) Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.

6) Instantaneous line-to-line and line-to-ground overcurrent trips.

7) Loss-of-phase protection.

8) Reverse-phase protection.

9) Short-circuit protection.

10) Motor overtemperature fault.

11) Line reactors for 30HP and larger.

E. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

F. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

G. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

H. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.

I. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.

J. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control.

K. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1) Output frequency (Hz).

2) Motor speed (rpm).

3) Motor status (running, stop, fault).

4) Motor current (amperes).

5) Motor torque (percent).

6) Fault or alarming status (code).

7) PID feedback signal (percent).

8) DC-link voltage (VDC).

9) Set-point frequency (Hz).

10) Motor output voltage (V).

L. Control Signal Interface: Provide VFD with the following:

1) Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2) Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

a. 0 to 10-V dc.

b. 0-20 or 4-20 mA.

c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs.

e. RS485.

f. Keypad display for local hand operation.

3) Output Signal Interface: A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

a. Output frequency (Hz).

b. Output current (load).

c. DC-link voltage (VDC).

d. Motor torque (percent).

e. Motor speed (rpm).

f. Set-point frequency (Hz).

4) Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.

b. Set-point speed reached.

c. Fault and warning indication (overtemperature or overcurrent).

d. PID high or low speed limits reached.

M. Serial Communications: The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. The use of third party gateways and multiplexers is not acceptable.

N. Bypass: Bypasses shall be furnished and mounted by the drive manufacturer as defined on the VFD schedule. All VFD with bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

1) A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses. UL Listed motor overload protection shall be provided in both drive and bypass modes.

2) The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the “Off” position before either enclosure may be accessed.

3) Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication.

4) The bypass system shall be designed for stand-alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.

5) Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications.

2.3 ENCLOSURES:

A. NEMA 1 enclosure for installation as a wall mounted unit complete with all options factory assembled for indoor use, NEMA 3R for outdoor use. Enclosure shall be fully ventilated and weather-proof to meet component requirements.

3.0 EXECUTION

3.1 EXAMINATION:

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

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

3.2 APPLICATIONS:

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.

B. Select rating of controllers to suit motor controlled.

3.3 INSTALLATION:

A. Install VFDs per manufacturer's written instructions, at locations indicated on Drawings.

B. Comply with mounting and anchoring requirements specified in Division 23 Sections.

C. Controller Fuses: Install fuses in each fusible switch.

D. Locate the AC Drive to prevent thermal faults or damage due to condensation or excessive ambient temperatures.

E. Install top of enclosures approximately 72 inches above finished floor.

F. When grouped, align the tops of all units.

G. The output, power conductors, to the motor shall not share a raceway with any other conductors. The control wiring shall not share a raceway with any other conductors.

3.4 IDENTIFICATION:

A. Label VFDs, components, and control wiring as specified in Division 26 Section "Electrical Identification".

3.5 CONNECTIONS:

A. Conduit installation requirements are specified in Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment.

C. 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 Standards.

3.6 FIELD QUALITY CONTROL:

A. Prepare for acceptance tests as follows:

1) Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.

2) Test continuity of each circuit.

B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

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

1) Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.5, 7.6, and 7.16. 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.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting VFDs.

E. Test Reports: Prepare a written report to record the following:

1) Test procedures used.

2) Test results that comply with requirements.

3) Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.7 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING:

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 CLEANING:

A. Clean VFDs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.10 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain VFDs. Refer to Division 01 Section Demonstration and Training.

3.11 WARRANTY

A. The VFD Product Warranty shall be 36 months from the date of factory shipment. The warranty shall include all parts, labor, travel time and expenses.

End of Section 23 09 13

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 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