2018

ROCK GAP ENGINEERING, LLC

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INDIAN HEALTH SERVICE

CROWNPOINT HEALTH CARE FACILITY MEDICAL GAS UPGRADE

PROJECT SPECIFICATIONS

Order No. HHSI16103024T

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SECTION 220000

PLUMBING INDEX

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract Documents, including General Special Conditions and the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

A. Furnish all service tools, equipment, etc., which are required for the complete installation of all Plumbing Work, as indicated on the Drawings and specified herein. Plumbing work indicated on the Drawings and/or specifications covering other trades shall conform to Division 22 of these Specifications.

B. Work or equipment not indicated or specified, which is necessary for the complete and proper operation of the Plumbing systems shall be accomplished without additional cost to the Owner.

C. Furnish all labor and materials required for plumbing service connections to all the various items of equipment requiring plumbing or piping throughout the project shown on the Contract Drawings (even if not shown on the Drawings). Coordinate with other trades for the installation of required connections and service.

1.3 PLUMBING DIVISION INDEX

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SECTION 220500

GENERAL PLUMBING REQUIREMENTS

PART 1- GENERAL

1.1 SUMMARY

A. Section Includes: General Plumbing Requirements specifically applicable to Division 22 sections in addition to Division 1- General Requirements.

B. SCOPE:

1. The work covered by this division consists of performing all operations in connection with the installation and repairs to medical gas system and plumbing including site utility work as indicated under this section. This entire section applies to all mechanical work and all mechanical sections of these specifications. This Contractor shall read and comply with all sections of these specifications including all General and Special Conditions.

1.2 REFERENCES

A. Standard Requirements:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. All work shall be executed in accordance with the local and state codes, ordinances, and regulations governing the particular class of work involved. This Contractor shall be responsible for the final execution of the work under this heading to suit these requirements. In the event of a conflict between the various codes and standards, the more stringent shall govern. Where these specifications and accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Engineer. The Engineer shall prepare any supplementary drawings required, illustrating how the work may be installed so as to comply. On approval of the change by the Engineer, the Contractor shall install the work in a satisfactory manner without additional cost to the Owner. On completion of the various parts of the work, the installation shall be tested by the constituted authorities and approved, and on completion of the work, this Contractor shall obtain and deliver to the Owner final certificates of acceptance. This Contractor shall furnish copies of each certificate to the Engineer.

C. The Contractor shall secure all permits and licenses for his work and shall pay all fees in connection with such permits and licenses.

D. The contractor shall hold and save the Owner free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

E. Any and all meter deposits and all utility extension costs shall be paid by the Contractor whose work is done in connection with the service that the meter is connected to.

F. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

1. AGA American Gas Association

		1515 Wilson Boulevard
		Arlington, VA 22209
2.	ANSI	American National Standards Institute
		1430 Broadway
		New York, NY 10018
3.	ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
		345 East 47th Street
		New York, NY 10017
4.	ASME	American Society of Mechanical Engineers
		345 East 45th Street
		New York, NY 10017
5.	ASPE	American Society of Plumbing Engineers
		960 Illuminating Building
		Cleveland, OH 44113
6.	ASTM	American Society for Testing and Materials
		1916 Race Street
		Philadelphia, PA 19103
7.	AWS	American Welding Society
		2501 NW 7th Street
		Miami, FL 33125
8.	CISPI	Cast Iron Soil Pipe Institute
		1499 Chain Bridge Road
		McLean, VA 22101
9.	FM	Factory Mutual System
		1151 Boston-Providence Turnpike
		Norwood, MA 02062
10.	FS	Federal Specification
		General Services Administration
		Specifications and Consumer Information Distribution
		Section (WFSIS)
		Washington Navy Yard, Building 197
		Washington, DC 20407

11.	NBFU	National Board of Fire Underwriters 5530 Wisconsin Avenue, Suite 750 Chevy Chase, Maryland 20815
12.	NEC	National Electric Code (of NFPA)
13.	NEMA	National Electrical Manufacturer's Association 2101 L Street, NW Washington, DC 20037
14.	NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
15.	NSF	National Sanitation Foundation Box 1468 Ann Arbor, MI 48106
16.	OSHA	Occupational Safety and Health Administration U.S. Department of Labor
17.	PDI	Plumbing and Drainage Institute 5342 Boulevard Place Indianapolis, Indiana 46208
18.	TIMA	Thermal Insulation Manufacturers Association Technical Services 1420 King Street Alexandria, VA 22314
19.	UL	Underwriters Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

G. Underwriters Laboratories Inc. (UL): All materials, appliances, equipment, devices or appurtenances shall conform to the applicable standards of Underwriters Laboratories Inc., where such standards have been established.

1.3 DRAWINGS

A. Drawings and specifications shall be considered as cooperative, and work or materials called for by one and not mentioned in the other, or vice versa, shall be done and furnished as though treated by both.

B. In the cases of discrepancies in figures, drawings, or specifications, the Engineer shall be notified immediately, and his decision shall determine the necessary adjustment. Without

such decision, said discrepancies shall not be adjusted by the Contractor save only at his expense, and, in case of any settlement or any complication arising from such adjustment to the Contractor, he shall bear all extra expense involved.

C. Should it appear that the work intended to be done, or any of the matters relative thereto, are not sufficiently detailed or explained on the drawings or specifications, the Contractor shall apply to the Engineer for such further drawings or explanations as may be necessary, allowing a reasonable time for the Engineer to supply same, and the Contractor shall conform to same as part of the Contract.

D. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, reference shall be made to the Architect\Engineer whose decision shall be final and conclusive. No alleged oral admission, condonation, or inadvertent neglect on the part of the Engineer will be accepted as an excuse for inferior work.

E. The mechanical plans do not give exact details as to elevations of ductwork and piping, exact locations, etc., and do not show all offsets, control lines, pilot lines, and other installation details. The Contractor shall carefully lay out his work at the site to conform to the structural conditions, provide proper grading of lines, to avoid all obstructions, to conform to details of installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated, satisfactory operational installation.

F. Should the particular equipment which any Bidder proposes to install, require other space conditions than those indicated on the drawings, the Bidder shall arrange for such space with the Engineer before submitting his bid. Should changes become necessary on account of failure to comply with these details, the Contractor shall make such necessary changes at his (the Contractor's own) expense.

G. The Contractor shall submit working scale drawings of all his apparatus and equipment which in any way varies from these specifications and plans which shall be checked by the Engineer and approved before the work is started, Contractor before work proceeds. Interference with structural conditions shall be corrected by the Contractor.

H. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

I. Utilities: The location, size, and pressure of utility lines are shown in accordance with the data given this office by others. As Engineers, we cannot and do not guarantee the accuracy of this data. Each Bidder shall check and verify this data. The points of connection to utility lines are approximate only and shall be verified by each Bidder prior to submitting his Bid.

J. Site visit: The Contractor shall visit the site prior to bidding and satisfy himself as the conditions under which the mechanical systems are to be installed. No subsequent allowance shall be made in his behalf for failure to make such a visit. Contractor shall examine all work noted under the demolition drawings and all new work and shall satisfy himself as to the extent of work required to be completed.

1.4 PRIOR APPROVALS

A. Each equipment item for which the Contractor desires to install equipment other than the specific item identified in the equipment schedule or equivalent equipment by manufacturers specifically named in the schedule, the Contractor shall bear full

responsibility to prove to the Engineer that the furnished equipment is equivalent to or better than the specified item. Failure to provide such proof will result in rejection of the shop drawing submittal by the Engineer. Prior written or verbal approval by the Engineer of equipment by other manufacturers will not relieve the Contractor of responsibility to provide equivalence. Prior approval is not required, however, any prior approval given is intended only to provide preliminary agreement that the alternate manufacturer may make equipment that complies with the specification requirements and not that all equipment manufactured by him is acceptable.

1.5 SHOP DRAWINGS

A. Shop drawings or fully descriptive catalog data shall be submitted by the Contractor for all items of material and equipment furnished and installed under this Contract. This shall include piping, medical equipment, plumbing equipment, control items, etc. The Contractor shall submit to the Engineer a sufficient number of copies of all such shop drawings or catalog data to provide him with as many review copies as he may need, plus three (3) copies for retention by the Engineer. No materials or equipment shall be installed until officially approved by the Engineer.

B. Before submitting Shop Drawings to the Engineer for review, the Contractor shall examine them and satisfy himself that they are correctly representative of the material or equipment to which they pertain. The Contractor shall so note these Drawings before submitting them. The Contractor's review of Shop Drawings is not intended to take the place in any way of the official review of the Engineer, and the Shop Drawings which have not been reviewed by the Engineer shall not be used in fabrication or installing any work.

C. The review of Shop Drawings or catalog data by the Engineer shall not relieve the Contractor from responsibility for deviations from the plans and Specifications unless he has, in writing, specifically called attention to such deviations as the time of submission and has obtained the permission of the Engineer thereon, nor shall it relieve him from the responsibility for error of any kind in Shop Drawings. When the Contractor does call such deviations to the attention of the Engineer, he shall state in his letter whether or not such deviations involve any extra cost. If this is not mentioned, it will be assumed that no extra costs is involved for making the change.

D. After receiving approval on the make and type of materials, the Contractor shall order such materials in sufficient time so that no delay or changes will be caused. This is done to facilitate progress on the job and failure on the part of the Contractor shall render him liable to stand the expense of any and all delays occasioned by failure on this part to provide necessary details. All shop drawings shall be delivered to the Engineer's office within thirty (30) days from the date of the contract.

E. Shop drawings will be returned unchecked unless the following information is included: reference to all pertinent data in the Specifications or on the drawings, size and characteristics of the equipment, name of the project and a space large enough to accept an approval stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings.

1.6 SUBMITTALS

A. Submittal data shall be organized in commercial quality, three ring binders with durable and cleanable covers. Product information for each piece of equipment shall be separated

by an indexing leaf with clear tabs. The product name and symbol (i.e. Medical Air Compressor, Medical Vacuum Pump, Alarm, Valves, etc.) shall be typed on white paper inserts and placed in appropriate tab. Complete data must be furnished showing performance, quality and dimensions. A signed review by the Engineer must be obtained before purchasing any equipment.

B. The following items shall be submitted for review by the Engineer but are not limited to:

1. Medical Alarm Panels
2. Piping
3. Valve boxes and Assembly
4. Area Alarm Panels
5. Medical Alarm Sensors
6. Pressure Sensors
7. Relief Devices
8. Medical Technicians Certification
9. Seismic Supports

1.7 QUALITY ASSURANCE

A. General: Comply with Division 1.

B. Welder Qualifications: Welders shall be certified by the American Society of Mechanical Engineers (ASME) National Certified Pipe for the type of work being performed. Current operators' certificates in accordance with ASME standards shall be on file at the site and shall be available to the Engineer for examination. Coupons shall be available for review by the Engineer.

C. Locations of all pipes, outlets, appliance, etc., as shown on the drawings, are approximate only and are understood to be subject to such revisions as may prove necessary or desirable at the time the work is installed. Each Contractor will be required to install his work with relation to existing building conditions and shall be entirely responsible for the correctness of his work with reference to finished elevations, etc. Piping shown on the drawings is diagrammatic only and their exact locations, depths, and invert elevations shall be as required for proper flow and coordination with other trades.

D. The contract drawing depicts graphically the arrangement of piping and ductwork. Should local conditions necessitate a rearrangement, or if any of the piping or ductwork can be installed to better advantage in a different manner, the Contractor shall, before proceeding with the work, prepare and submit three (3) copies of Drawings of the proposed arrangement for the Engineer's review.

E. If the Contractor proposes to install equipment, including piping and ductwork, requiring space conditions other than those shown, or to rearrange the equipment, he shall assume full responsibility for the rearrangement of the space and shall have the Engineer review the change before proceeding with the work. The request for such change shall be accompanied by Shop Drawings of the space in question.

F. Each Contractor is responsible for the proper location and size of all slots, holes, or openings in the building structure pertaining to his work, and for the correct location of pipe sleeves.

G. Each Contractor shall coordinate his work with that of all other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Drainage lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork.

H. All oiling devices and all parts of equipment requiring adjustment shall be easily accessible. Lubricate all equipment properly in accordance with manufacturer's instructions. Furnish zerk grease fittings on all greaseable bearings.

I. Equipment and Materials: The materials and equipment shall be new and shall be the standard products of the manufacturers regularly engaged in the production of Plumbing, Heating, Cooling, Ventilation, and Fire Protection Equipment, and shall be the manufacturer's latest standard design. Where two or more units of the same class of equipment are required, these units shall be the products of the same manufacturer. However, the component parts of the systems need not be the products of the same manufacturer. Specific equipment specified hereinafter is to be considered a standard of quality and operation. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the drawings. Reference shall be made to the schedules for specific information. The capacities shown are minimum capacities. Variations in the characteristics will be permitted only on written approval of the Engineer. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Insofar as is possible all items of the same type (i.e., pumps, pressure vessels, etc.) shall be by the same manufacturer. Where installation instructions are not included in these specifications or on the plans, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is to be installed (7,000 feet above sea level).

J. Excavation and Backfilling: This Contractor shall do all necessary excavation and backfill for the installation of the Mechanical systems as may be required. Curb cuts, asphalt and concrete patching, cutting and patching existing floor, etc., shall be part of this Contractor's responsibility. No extra payment will be made for rock excavation. Trenches for all underground piping shall be excavated to the required depths. The bottoms of trenches shall be tamped hard and graded to secure maximum fall. Bell holes shall be excavated to assure the pipe resting for its entire length on solid ground. Should rock be encountered, it shall be excavated to a depth of 6 inches below the bottom of the pipe, and before laying the pipe, the space between the bottom of the pipe and the rock surface shall be filled with gravel, thoroughly tamped. Pipe laid in trenches dug in fill shall be supported down in the trenches and shall be filled. No roots, rocks or foreign materials of any description shall be used in backfilling the trenches. The backfill material shall be identical to the surrounding fill material and shall be placed in 6-inch layer, wetted, and compacted to the density of the adjacent soil. See Division 2 for additional information for site utilities. All surplus materials shall be hauled from the project by the Contractor at his expense.

K. Cutting and Repairing:

1. Responsibility of the Contractor whose work is involved. Coordinate with others to prevent unnecessary cutting and repairing.

2. Lay out and locate equipment, openings, and chases. Install sleeves, inserts, and supports. Arrange with those whose work is involved to do cutting and replacing caused by negligence or error with costs reimbursed by the Contractor at fault. Cutting and replacing of existing work shall be the responsibility of the Contractor whose work is being installed.

3. Removal or terminating connections of existing work which is abandoned or replaced shall also be done hereunder to provide correct and finished work.

L. Foundations: All equipment shall be provided with suitable foundations and supports. It shall be the responsibility of the Contractor to provide for the proper locations of these foundations and supports.

1. All concrete foundations required by equipment furnished by the Mechanical Contractor shall be constructed by them (except where otherwise noted) the conformity with the recommendations of the manufacturer of the respective equipment, and with the approval of the Engineer. All corners of the foundations shall be neatly chamfered. Foundation bolts shall be placed in the forms when the concrete is poured. Allow 1 inch below the equipment base for alignment, leveling and grouting with nonshrinking grout. Grouting shall be done after the equipment is leveled in place. After the grout has hardened, the foundation bolts shall be pulled up tight and the equipment shimmed, if necessary. After removal of the forms, the surface of the foundation shall be rubbed.

2. Unless otherwise noted, foundations shall be a minimum of 6-inch high. All concrete work performed by these Contractors shall conform entirely to the requirements of the Concrete Specifications which describe this class of work.

M. Code Requirements: Comply with state and local code requirements and ordinances. Call for inspections required by responsible building inspection authority.

N. Applicable Building Codes and Ordinances: Including the latest edition of each code, but not limited to the following:

1. International Building Code.

2. Uniform Mechanical Code.

3. Uniform Plumbing Code.

4. Governing Fire Department Requirements

5. Utility Company Requirements

6. National Fire Protection Association Standards

7. NFPA 70 - National Electrical Code

8. NFPA 99 – Health Care Facilities Code

9. NEPA 90B - Installation of Warm Air Heating and Air Conditioning Systems

10. NFPA 13 - Sprinkler Systems

11. NFPA 101 - Life Safety

O. ACCESS PANELS

1. Similar to Milcor, or as noted on the drawings, size as required for concealed expansion joints, valving, gauges, balancing dampers, valves, traps, pitot stations, equipment and similar items requiring accessibility. Notify the General Contractor of each access panel location and the required size. Panels shall be proper type for ceiling or wall in which they are installed. The panels shall be furnished under this section of the Specifications, unless otherwise directed, but shall be coordinated to be compatible with walls and ceilings furnished under other sections.

1.8 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1.

B. Large Items: Make arrangements with other trades on the job for introduction into the building of equipment too large to pass through finished openings.

C. Acceptance: Check and sign for materials to be furnished by others for installation under Division 22 upon delivery. Contractor shall be responsible for the storage and safekeeping of such materials from time of delivery until final acceptance.

D. Protection: Close ends of pipe at the close of each working day during construction to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Protect fixtures and equipment against damage during mechanical work with heavy paper or plastic until final clean-up.

E. Storage: Store equipment in covered enclosure or wrap with weather tight 6 mil Visqeen.

F. Shipping Protection: Protective casings, crating, and coverings to remain in place until start-up of equipment.

1.9 PROJECT CONDITIONS

A. Performance: All systems are to be rated at 7,000 ft. elevation.

1.10 SEQUENCING AND SCHEDULING

A. General: Comply with Division 1.

B. Schedule: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

C. Utility Interruptions: Schedule mechanical utility interruptions with the Engineer/Owner minimum of seven (7) days prior to the requested outage. Plan work so that duration of the interruptions a maximum of one day.

1.11 CONTROLS WIRING AND ELECTRICAL EQUIPMENT

A. All mechanical equipment controls wiring, conduit, relays, interlocks, and all accessories required for a completely operational controls system shall be the complete responsibility of the mechanical contractor. The mechanical contractor has the option to hire the project electrical contractor or any qualified controls contractor to install mechanical controls

wiring and conduit. Contractor shall be responsible for coordination requirements between mechanical, electrical, and controls subcontractors.

B. Electrical items such as disconnect switches and motor starters associated with equipment provided by Division 22, when specifically mentioned to be furnished by the Mechanical Contractor, whether in these specifications or on the Electrical or Mechanical Drawings, shall be furnished by the Contractor. These items shall be mounted and connected as required for a completely operational system. See Control Systems Specification for further information.

C. All electrical equipment characteristics (voltage, etc.) must be verified by the Contractor prior to ordering. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first inform the Engineer of the change and shall then coordinate the change with the Electrical Contractor and shall pay all additional charges in connection with the change.

D. All motors shall meet all the requirements of all Electrical Divisions.

1. All motors shall be built in accordance with the current applicable IEEE, ASA, and NEMA standards. All general-purpose motors shall be open drip-proof machines for installation indoors and/or in protected locations. Totally enclosed fan cooled (TEFC) motors shall be used in all areas of exposure to weather or other environmental contamination. All motors shall have copper windings. All motors to have minimum power factor of 85% or have switched correction to 90%. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 104°F rise and total temperature rise of 150°F ambient and when powered from the system voltage feeding the motor. TEFC motors shall a service factor of 1.00 with total temperature is of 65°C in the above conditions. Motors located in areas exceeding 104°F ambient shall be factory-rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Single phase motors connected on loads requiring high starting torque shall be capacitor-start induction motors.

1.12 PROTECTION AGAINST HAZARDOUS CONDITIONS

A. The Contractor shall take precautions against hazardous construction conditions at all times during construction. The final condition of the facilities shall be safe, and where safety to operating personnel is jeopardized, suitable signage shall be posted.

B. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operating personnel, shall be cut back and/or protected to reduce the risk of injury. All openings between floors shall be protected with barriers around the openings, gratings across the openings, or steel bars through the openings to avoid and protect against injury.

1.13 HAZARDOUS SIGNS

A. Equipment room contains moving or rotating parts, floor openings, or other potentially hazardous environments and shall include a sign on the door entering it that shall read similar to the following: **Hazardous Area - Authorized Personnel Only.**

1.14 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Mechanical Contractor shall furnish to the Owner a bound (three (3) ring binder) manual in triplicate, containing complete repair parts lists, and operating, service, and maintenance instructions on all mechanical equipment, fixtures, and systems, as noted below:

1. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Engineer, Sub-consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

2. For Each Product System: List names, addresses and telephone numbers of Sub-contractors and suppliers, including local source of supplies and replacement parts.

3. Product Data: Mark each sheet to clearly identify specific product and component parts, and data applicable to installation. Delete inapplicable information.

4. Warranties and Bonds: Bind in copy of each.

5. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

6. Include color-coded wiring diagrams as installed for control system.

7. Operating Procedures: Include start-up, break-in and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.

8. Maintenance Requirements: Include routine procedures and guide for trouble-shooting, disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

9. Provide servicing and lubrication schedule and list of lubricants required.

10. Include manufacturer’s printed operation and maintenance instructions.

11. Include sequence of operation by controls manufacturer.

12. Provide original manufacturer’s part list, illustrations, assembly drawings and diagrams required for maintenance.

13. Provide control diagrams by controls manufacturer as installed.

14. Provide charts of valve tag numbers, with locations and functions of each valve, keyed to flow and control diagrams.

15. Provide list of original manufacturer’s spare parts and recommended quantities and to be maintained in storage.

16. Include Test and Balance (T&B) Reports.

17. Include manufacturer representative’s start-up reports.

B. The Mechanical Contractor shall also provide training to the Owner's operation and maintenance personnel.

1.15 OPERATION PRIOR TO ACCEPTANCE

A. The Owner shall have the right to operate any and all apparatus as soon as and as long as it is in operating condition, after Owner personnel have received operational training, whether or not such apparatus has been accepted as complete and satisfactory, except that this shall not be construed to mean operations before any required alterations or repairs have been made. This operation does not indicate acceptance of the equipment by the Owner. When the Contractor enters into a contract with the Owner, he agrees to the above.

1.16 WARRANTY AND SERVICE PROGRAM

A. Due to the critical performance requirements and to clearly establish warranty responsibility for this project, the Contractor shall provide a full-service maintenance and warranty program to the Owner for one full year after substantial completion.

B. This service program shall be included as part of the base bid and shall include service, maintenance, repair, replacement, lubrication, temperature control calibration and repairs, and documenting proof for all service and maintenance work on all equipment and system furnished by the Contractor.

C. A single representative in the employment of the Contractor shall be responsible for coordination and follow through of this program. This representative's name and phone number shall be submitted to the Owner as part of the maintenance manuals and supportive data. The Contractor shall respond to a request for service with 24 hours if so requested.

D. During this first year of operation, the following sequence of maintenance service shall be performed as a minimum.

1. Clean strainers in piping.

2. Pumps be lubricated and oiled once every four (4) months.

3. Controls shall be calibrated throughout the facility at the end of six (6) months (following substantial completion). Any leaks in the piping systems shall be repaired.

4. All equipment manufacturer's service recommendations shall be followed during this period.

1.17 CLEANING

A. This Contractor shall remove from the building construction site all rubbish and dirt as it accumulates under the contract. At completion, all areas shall be broom cleaned and all obstructions, surplus materials, etc., removed.

1.18 GUARANTEE

A. The Contractor shall guarantee all materials, equipment, and workmanship furnished and installed by him under this Contract, to be free from all defects of workmanship and materials, and shall agree to replace at his expense, without expense to the Owner, at any time within one year after installation is accepted by the Engineer, any and all defective

equipment, parts, etc., that may be found. (This excludes normal maintenance and daily servicing of equipment which is the Owner's responsibility.)

1.19 FLOOR, WALL, AND CEILING PLATES

A. Where exposed pipes pass through floors, finished walls, or finished ceiling, they shall be fitted with chromium-plated escutcheons of an approved pattern. Escutcheons and plates in Mechanical Rooms do not require chrome finish.

B. This Contractor shall be responsible for providing and installing all counter flashing. All openings in the roof shall be flashed and counterflashed. Use four-pound lead flashing materials for all vent lines and welded flashing in steel lines passing through roof. The Mechanical Contractor shall notify the General Contractor where each roof penetrations are and the size of the opening.

1.20 PIPE SLEEVES

A. Schedule 40 steel pipe sleeves or pipe sleeves made of No. 20 gauge galvanized steel, properly secured in place with approximately 1/4" space between each sleeve and the surface of the pipe and/or insulation passing through it, shall be provided for all pipes passing through concrete floors, roofs, and masonry walls. All pipe sleeves shall be fixed in place as the walls and floors are built up. The Contractor shall furnish and locate all sleeves and pipes passing through concrete floors, exterior masonry walls, and roofs shall be made watertight with approved non-hardening plastic material. Sleeves through pipe chase or equipment room floors shall project a minimum of 2-inch above the floor and shall be of black steel pipe with waterproof flange at center of floor thickness. Each sleeve through a fireproof wall shall be packed with approved fireproof rope in the annular space.

1.21 PIPE HANGERS

A. Shall conform to the requirements of 2018 NFPA 99, 2015 UPC, MSS-SP-69, and MSS-SP-58.

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

C. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting, nor shall it be supported from equipment connection.

D. Expansion bolts shall be Ackerman-Johnson or Hilti.

E. Beam clamps suitable for use with this type of steel construction involved shall be Grinnell.

1.22 ISOLATION

A. Excessive vibration or objectionable noise created in any part of the building by the operation of any equipment furnished and/or installed under the Mechanical Contract will be extremely objectionable and the Contractor shall take all precautions against the same

by isolating the various items of equipment from the building structure and by such other means as may be necessary to eliminate all excessive vibration and objectionable noise produced by any equipment installed by them, and consequently, they shall design all foundations, supports, etc., for their equipment, and all piping with this end in view. In addition, these Contractors shall supervise the construction of all foundations and supports, whether they build them or not, in order that they may be constructed in such a manner as to prevent the transmission of objectionable noise and/or excessive vibration. Submit calculations on all vibration isolation equipment.

B. All equipment having moving parts shall be isolated from the building structure by means of Korfund isolation materials, unless specifically noted otherwise. All isolators shall be the same brand and shall be supplied from the same source. Equipment manufacturer's recommendations shall be followed in the isolation of equipment.

C. Vibration isolators shall have sufficient resilience to meet the following minimum efficiencies:

Motor HP	Equipment Room
Up to 5	90%
7-1/2 to 15	93%

D. Spring isolators shall be of the housed type with ribbed pads bonded to the underside of the baseplate or may be unhoused stable springs. Isolators shall be furnished with snubbers and limit stops where so recommended by the equipment manufacturer.

E. The Supplier of the isolating equipment shall, upon completion of the job, check all isolating materials and verify that they are installed properly, and submit a report in writing to the Engineer.

1.23 TESTING

A. Before completion of this project, the Mechanical Contractor shall test all materials and equipment which normally require testing. All piping, etc., shall be tested to meet code requirements or the Specification requirements, whichever is more stringent.

B. All equipment shall be operated sufficiently long enough to prove to the Engineer that the equipment performs satisfactorily and meets the requirements set forth on the Plans or in these Specifications.

1.24 CERTIFICATIONS

A. Before receiving final payment, the contractor shall verify that all equipment furnished, and all work done is in compliance with all applicable codes mentioned in these Specifications. Submit certifications and acceptable certificates to the Engineer.

1.25 GENERAL PIPING INSTALLATION REQUIREMENTS

A. Provisions for Drainage: All piping systems shall be installed so that they may be easily drained. Drain caps, plugs, or hose bibbs shall be installed at low points. Grade piping toward drain locations.

B. Alignment: All installed pipe lines shall be straight and shall remain straight against strains. Proper allowance shall be made for expansion and contraction.

C. Clean as Installed: All piping shall be kept free from scale or loose dirt when installed, and must be kept clean during the completion of the installation. All openings in the piping system shall be capped or plugged while awaiting further connections. All detergents, solvents and other cleaning agents shall be compatible with the materials of fabrication of the system in which they are used. They shall not adversely affect the materials of mechanisms in the systems and they shall be acceptable to equipment manufacturers. All detergents, solvents, and other cleaning agents shall also be compatible with the process streams to be handled by the systems in which they are used.

D. Insulated Fittings: Install between any dissimilar metals such as steel and copper.

E. Expansion and Contraction: The Contractor shall make all necessary provisions for expansion and contraction with proper fittings, anchors, dresser couplings, loops, etc. Install flexible connectors on each pipe at each building expansion joint.

F. Welding: Refer to Paragraph 1.29 of this section of these specifications.

G. Bending: No bending of pipe will be permitted.

H. General: The installation shall be coordinated with respect to space available with heating, cooling, ventilating, and electrical installation. In every instance where there is a conflict in the routing of the piping and the ducting, the routing of the ducting shall govern. Installed piping shall not interfere with the operation or accessibility of doors or windows, shall not encroach on aisles, passageways, and equipment, and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping, installation is not permitted. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping above ground shall be run parallel with the lines of the building unless otherwise noted on the drawings. Unless otherwise shown on the drawings, horizontal piping shall pitch down in the direction of flow with grade of not less than 1 inch in 40 feet. Piping connections to equipment shall be in accordance with details shown on the drawings or as recommended by the equipment manufacturer. Service pipe valves and fittings shall be kept a sufficient distance from other work to permit finished covering not less than 1/2 inch from such other work, and not less than 1/2 inch between finished covering on the different services.

I. Installation of Valves: Valves shall be installed at the locations shown on the drawings and where specified and where directed at site. Gate valves shall be used unless otherwise shown, specified, or directed. All valves shall be installed with their stems horizontal or above.

J. All valves which must be used during operation, all control valve assemblies, instrument control cases, liquid level controls, gage glasses, orifices, relief valves, and other equipment which must be observed, adjusted, or serviced during operation shall be located conveniently accessible from an operating platform or grade.

K. In general, relief valves within processing unit limits shall be located conveniently accessible from an operating platform or grade.

1. Those in non-hazardous service, such as water, shall discharge directly to outside.

2. Relief valves should have no piping between the vessel or line and the valve inlet, except as shown on the drawings.

3. Relief valves shall be installed in a vertical position. Vent piping shall be braced and supported in a manner that will not produce excessive stresses in the relief valve and will permit removal of the relief valve without necessary temporary supports for the vent lines.

L. Equipment Connections: All piping connections to pumps and other equipment shall be installed without strain at the pipe connection of the equipment. The contractor shall be required as directed to remove the bolts in flanged connections or disconnect piping to demonstrate that the piping has been so connected. Pipe connections to equipment shall be made with unions or flanged fittings. Provide removable headers for large equipment for service access.

M. Joints

1. Flanged Joints: All flanged joints shall be face matched. Raised face flanges shall not be mated to flat-faced cast-iron flanges on valves or equipment. The raised face must be turned off. All flanged bolt holes shall straddle the horizontal and vertical center line unless otherwise noted.

2. Screwed Joints: Screwed pipe joints shall have American Standard Taper Pipe Threads ANSI-B2.1 Latest Edition. Burrs formed when cutting pipe shall be removed by reaming. Care shall be taken that the inside of pipe is thoroughly clean and free of cutting oil and foreign matter before installation. Joints shall be made perfectly tight by the use of Teflon tape or approved Teflon thread sealing and lubricating compound.

3. Solder-Joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool or wire brush before seating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for serrated fittings on water, compressed air below 60 psig, and vacuum lines shall be made with a 95 percent tin and 5 percent antimony. Cored solder or solder containing lead will not be permitted.

N. Reducers: Reduction in pipe size shall be made with one piece reducing fittings. Bushings reducing at least two pipe sizes will be acceptable only when there is no room for reducing couplings or swaged nipples.

O. Unions: All piping unions shall be of the ground joint type constructed from materials equivalent in alloy composition and strength to other fittings specified with which they are used. Union Pressure classes and end connections shall be the same as the fittings used in the lines with the unions. Steel unions shall have hardened stainless steel seating surfaces on both faces.

P. Hanger Supports:

1. All hanger rods used to support piping Shall conform to the requirements of 2018 NFPA 99, 2015 UPC, MSS-SP-69, and MSS-SP-58.

2. Do not bend rods to circumvent an obstruction.

3. Loads on hanger rods shall be applied in direct tension. Do not apply compression, lateral or moment loads to hanger rods. Install bracing or additional supports to prevent hanger rod from incurring non-tension loading.

4. Do not create offsets in rods; use only in-line couplers, and only when length of coupled rod exceeds standard available length (typically 12 feet), or when full lengths cannot be placed in position. Provide additional horizontal bracing to prevent swaying of supported piping or equipment.

5. Do not straighten bent rods for subsequent use. If a rod becomes bent, cut off and discard the bent portion. Remaining straight portion of rod may be used.

1.26 WELDING

A. All welding of piping covered by this specification, regardless of condition of service shall be accompanied as follows:

1. The welding shall be in accordance with the recommendations of the American Welding Society. Mitering of pipe to form elbows, notching to form these, or any similar construction will not be permitted. Welding fittings shall be installed on all welded lines. Joints to be welded shall be properly aligned and spaced, using special welding clamps where necessary. All welders to be employed shall have passed qualification tests prescribed by the National Certified Pipe Welding bureau (or by another reputable testing laboratory or agency as indicated in the General Notes on Sheet MG-1) using procedures approved by the American Society of Mechanical Engineers or the American Welding Society. The welders will be required to pass qualification tests when the work of the welder creates a reasonable doubt as to his proficiency. Tests shall be conducted at no additional expense to the Owner.

2. Each welder shall, in addition to having passed the prescribed qualification tests (as noted in Paragraph 1.30.A.1), prepare sample coupons at the job site on a portion of pipe that is cut such that the cross section of the weld is open to view. The sample weld should be prepared using a 6-inch diameter pipe. The sample shall reflect a continuous weld with perpendicular cut out to show the weld in cross sectional view. This sample, when accepted and approved by a certified welding inspector, shall be used as a standard of quality to compare to other welds that this welder will be performing on the job. This same sample weld will also be a basis for accepting or rejecting the welder for working on this project. The sample weld shall be identified with a date and the welder's name and shall be kept at the site throughout the project.

3. All welding on pressure piping shall conform to all of the requirements of the American Society of Mechanical Engineers Code for Pressure Piping - B31.1 (An American National Standards Institute publication), as defined in the latest edition of the ANSI Power Piping B31.1 Manual. All welding shall also conform to all of the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. All chapters, current addenda and supplements of these manuals shall apply. This code shall be used to establish standards of performance and quality of welds. However, the Owner reserves the right to perform radiographic testing of all welds, to compare any of the welds to the approved "standard" sample welds of each welder, and to compare the welds to

the welding diagrams and sketches of those recommended in the ANSI B31.1 Power Piping Manual. The intent is to obtain the highest quality welding job possible. The cost of any initial radiographic testing, for random inspection, shall be paid for by the Owner. If radiographic random testing reveals that a weld is defective, the Contractor shall bear the cost of all repairs and re-testing necessary to be made to subject weld until conformance with radiographic tests is reached. The potential for random radiographic testing and welding quality control applies to all pressure piping systems in this project, including systems below 100 psig. If a question should arise regarding the possibility of faulty welding or if there are obvious visual defects in the welding, the Contractor shall be required to correct such deficiencies to a quality level consistent with the recommendations, welding diagrams and sketches in the ANSI B31.1 Manual. The quality level shall also reflect that of the approved sample welds accomplished by each welder for this particular project.

1.27 TESTING FOR PIPING SYSTEMS

A. General: Before insulation is applied, all piping, equipment, and accessories installed under this contract shall be inspected and tested by the Contractor. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying tests. Prior to performing tests, all lines shall be "blown" free of all loose dirt and foreign particles. The lines shall then be thoroughly flushed with water (liquid lines only) at a sufficient flow rate and period of time, to ensure complete cleaning of the lines of all dirt, scale, and foreign matter. Satisfactory flushing of the lines shall be subject to approval. After testing and flushing lines, all filters and strainers shall be cleaned.

B. Safety: Since the Risk of failure, with the attendant possibility of injury, is appreciable greater with further testing, all safety measures required by codes or ordinance or reasonable applicable to the situation shall be taken.

C. Concealment: Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Compression joint underground piping may be backfilled prior to pressure test except that joints shall remain exposed until after the test, but tie rods, clamps, etc., shall be in place and fastened.

D. Pressure Ratings: These tests shall not be used to establish pressure ratings.

E. System Protection: Protect all piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating. Note that where significant differences in elevation exists, there is a risk of overpressure in the lower portions of the system in order to attain test pressure in the upper portion of the system

F. Test Temperature: Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes require testing above a specified minimum temperature.

G. Sectionalizing: Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

H. Temporary Supports: During hydrostatic testing of lines provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

I. Testing: Piping shall be tested hydrostatically at the test pressures specified and shall show no drop in pressure in a 2 hour period. Leaks shall be located by soap testing

1. Test Pressures:

a) Medical vacuum and gas piping: as required by governing code

J. Test Report

1. A detailed report of pressure tests on piping and equipment shall be forwarded in duplicate to the Engineer. This report shall show date of test, lines tested, test medium, length of time test pressure was held, pressure drop or rise, and extent of venting or repressurizing.

1.28 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other sections of these specifications covering the work of other trades which must be carried out in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay or absence of coordination.

1.29 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions covering the mechanical work at the building. No extra compensation shall be claimed or allowed on account of difference between actual dimensions and those indicated on the drawings. He shall examine the adjoining work on which Mechanical work is dependent for maximum efficiency, and shall report any work which must be corrected. No waiver of responsibility for defective work shall be claimed or allowed due to failure to report unfavorable work conditions affecting Mechanical work.

1.30 SAFETY GUARDS

A. The Mechanical Contractor shall furnish and install 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. Provide coupling guards on all rotating shafts.

1.31 PROTECTION

A. All work, equipment, and materials shall be protected at all times to prevent obstruction, damage, or breakage. All pipe openings shall be closed with caps or plugs during installation. All equipment shall be covered and protected against dirt, water, chemical, or mechanical injury. At the completion of the work, all equipment shall be thoroughly cleaned and the entire system shall be delivered in a perfect, unblemished condition.

1.32 PAINTING AND IDENTIFICATION

A. All equipment shall be delivered to the job with suitable factory finish. Should the finish be marred in transit or during installation, it shall be finished to present a neat, workmanlike appearance.

B. Except as elsewhere hereinafter specifically required, any painting of equipment, piping, ductwork, grilles, insulation, etc., furnished and installed under this Section of the Specifications will be done by the Painting Contractor. However, the Mechanical Contractor shall leave his equipment clean and free from any grease, dirt, rust, etc., and in suitable condition for painting.

C. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent there being rendered illegible during the painting operation.

D. The piping shall be painted the basic color as indicated in other sections of these specifications and shall be marked as required in NFPA 99. Locate additional labels as required in Mechanical Rooms.

1.33 RECORD DRAWINGS

A. The Contractor shall, during the execution of the work, maintain a complete set of drawings upon which all dimensional locations of equipment piping and all deviations and/or changes in the work shall be recorded. Water, storm, and drainage mains shall be delivered to the Engineer in good condition upon the completion and acceptance of the work and before final payment is made.

1.34 SUPPLIER RESPONSIBILITY

A. Each supplier, whether furnishing equipment as specified or as a substitution shall be responsible for certifying that the equipment is properly installed and that the warranty is valid. Submit written reports on the installation and the equipment performance when requested to do so by the Engineer (or his representative). Each supplier shall be responsible for furnishing qualified personnel at the job site at anytime requested by the Engineer (or his representative) during the construction or warranty periods.

END OF SECTION

SECTION 220548

SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Provide seismic restraint in accordance with the requirements of this section and referenced Codes in order to maintain the integrity of nonstructural components of the building so that they remain safe and functional in case of seismic event.

B. Definitions: Non-structural building components are components or systems that are not part of the building's structural system whether inside or outside, above or below grade. Non-structural components of buildings include:

1. Mechanical Elements: Medical gas systems.

1.2 RELATED WORK:

A. 220500 General Plumbing Requirements

B. 226000 Gas Systems for Healthcare Facilities

1.3 QUALITY CONTROL:

A. Shop-Drawing Preparation:

1. Have seismic-force-restraint shop drawings and calculations prepared by a professional structural engineer experienced in the area of seismic force restraints. The professional structural engineer shall be registered in the State of New Mexico.

2. Submit design tables and information used for the design-force levels, stamped and signed by a professional structural engineer registered in the State of New Mexico.

B. Coordination:

1. Do not install seismic restraints until seismic restraint submittals are approved Engineer.

2. Coordinate and install trapezes or other multi-pipe hanger systems prior to pipe installation.

1.4 SUBMITTALS:

A. Submit a coordinated set of equipment anchorage drawings prior to installation including:

1. Description, layout, and location of items to be anchored or braced with anchorage or brace points noted and dimensioned.

2. Details of anchorage or bracing at large scale with all members, parts brackets shown, together with all connections, bolts, welds etc. clearly identified and specified.

3. Numerical value of design seismic brace loads.

4. For expansion bolts, include design load and capacity if different from those specified.

B. Submit prior to installation, a coordinated set of bracing drawings for seismic protection of piping, with data identifying the various support-to-structure connections and seismic bracing structural connections, include:

1. Single-line piping diagrams on a floor-by-floor basis. Show all suspended piping for a given floor on the same plain.

2. Type of pipe (Copper, steel, cast iron, insulated, non-insulated, etc.).

3. Pipe contents.

4. Structural framing.

5. Location of all gravity load pipe supports and spacing requirements.

6. Numerical value of gravity load reactions.

7. Location of all seismic bracing.

8. Numerical value of applied seismic brace loads.

9. Type of connection (Vertical support, vertical support with seismic brace etc.).

10. Seismic brace reaction type (tension or compression). Details illustrating all support and bracing components, methods of connections, and specific anchors to be used.

C. Submit prior to installation, bracing drawings for seismic protection of suspended ductwork and suspended electrical and communication cables, include:

1. Details illustrating all support and bracing components, methods of connection, and specific anchors to be used.

2. Numerical value of applied gravity and seismic loads and seismic loads acting on support and bracing components.

3. Maximum spacing of hangers and bracing.

4. Seal of registered structural engineer responsible for design.

D. Submit design calculations prepared and sealed by the registered structural engineer specified above in paragraph 1.3A.

E. Submit for concrete anchors, the appropriate ICBC evaluation reports, OSHPD pre-approvals, or lab test reports verifying compliance with OSHPD Interpretation of Regulations 28-6.

1.5 APPLICABLE PUBLICATIONS:

A. The Publications listed below (including amendments, addenda revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only.

1. American Concrete Institute (ACI): Building Code Requirements for Structural Concrete, (ACI 318-02), and Commentary (ACI 318R-02).

2. American Institute of Steel Construction (AISC): Load and Resistance Factor Design, Volume 1, Second Edition.

3. American Society for Testing and Materials (ASTM):

   A36/A36M-04 Standard Specification for Carbon Structural Steel.

   A53/A53M-02 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

   A307-03 Standard Specification for Carbon Steel Bolts and Studs; 60,000 PSI Tensile Strength.

   A325-04 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

   A325M-04 Standard Specification for High-Strength Bolts for Structural Steel Joints [Metric].

   A490-04 Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.

   A490M-04 Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric].

   A500-Rev.A-04 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

   A501-01 Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

   A615/615M-Rev.A-04 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

   A992/A992M-04 Standard Specification for Steel for Structural Shapes for Use in Building Framing.

   A996/996M-04 Standard Specification for Rail-Steel and Axel-Steel Deformed Bars for Concrete Reinforcement.

   E488-96 Standard Test Method for Strength of Anchors in Concrete and Masonry Elements.

4. International Building Code (IBC) 2015 Edition.

5. National Uniform Seismic Installation Guidelines (NUSIG).

6. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Seismic Restraint Manual - Guidelines for Mechanical Systems, latest Edition and Addendum.

7. Manufacturing Standardization Society (MSS):

   MSS-SP-72-99 Ball Valves With Flanged or Butt Welding For General Purpose

   MSS-SP-110-96 Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

MSS-SP-73-03	Brazing Joints for Copper and Copper Alloy Solder Pressure Fittings
MSS-SP-69	Pipe Hangers and Supports – Selection and Application
MSS-SP-58	Pipe Hangers and Supports Materials, Design and Manufacturers Selection, Application and Installation

1.6 REGULATORY REQUIREMENT:

A. IBC 2015.

PART 2 – PRODUCTS

2.1 STEEL:

A. Structural Steel: ASTM A36.

B. Structural Tubing: ASTM A500, Grade B.

C. Structural Tubing: ASTM A501.

D. Steel Pipe: ASTM A53/A53M, Grade B.

E. Bolts & Nuts: ASTM A307.

2.2 CAST-IN-PLACE CONCRETE:

A. Concrete: 28 day strength, f'c =.3,000psi

B. Reinforcing Steel: ASTM A615/615M or ASTM A996/A996M deformed.

PART 3 – EXECUTION

3.1 CONSTRUCTION, GENERAL:

A. Provide equipment supports and anchoring devices to withstand the seismic design forces, so that when seismic design forces are applied, the equipment cannot displace, overturn, or become inoperable.

B. Provide anchorages in conformance with recommendations of the equipment manufacturer and as shown on approved shop drawings and calculations.

C. Construct seismic restraints and anchorage to allow for thermal expansion.

D. Testing Before Final Inspection:

1. Test 10-percent of anchors in masonry and concrete per ASTM E488, and ACI 355.2 to determine that they meet the required load capacity. If any anchor fails to meet the required load, test the next 20 consecutive anchors, which are required to have zero failure, before resuming the 10-percent testing frequency.

2. Before scheduling Final Inspection, submit a report on this testing indicating the number and location of testing, and what anchor-loads were obtained.

3.2 EQUIPMENT RESTRAINT AND BRACING:

A. All Mechanical Equipment.

3.3 MECHANICAL AND MEDICAL GASES PIPING

A. Support and brace mechanical and medical gases piping to resist directional forces lateral, longitudinal and vertical.

B. Provide supports and anchoring so that, upon application of seismic forces, piping remains fully connected as operable systems which will not displace sufficiently to damage adjacent or connecting equipment, or building members.

C. Seismic Restraint of Piping:

1. Design criteria:

a. Piping resiliently supported: Restrain to support 120 -percent of the weight of the systems and components and contents.

b. Piping not resiliently supported: Restrain to support 60 -percent of the weight of the system components and contents.

D. Piping Connections: Provide flexible connections where pipes connect to equipment. Make the connections capable of accommodating relative differential movements between the pipe and equipment under conditions of earthquake shaking.

END OF SECTION 22054

SECTION 226000

GAS SYSTEMS FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Medical Healthcare Gas Systems: Consisting of oxygen and medical compressed air services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets, rough-ins, ceiling services, gages, alarms including low voltage wiring, control panels, cylinder manifolds, air compressors, electric motors and starters, air dryers, filters, pressure regulators, dew point, carbon monoxide monitors and all necessary parts, accessories, connections and equipment.

B. Oxygen System: Ready for connection to medical gas outlets and cylinders but not including tank and cylinders.

C. Supply Lines Outside of Building (including PVC protective pipe): As specified in this Section.

D. Healthcare gas system alarm wiring from equipment to alarm panels.

1.2 RELATED WORK

A. Sealing around pipe penetrations to maintain the integrity of time rated construction.

B. Sealing around pipe penetrations through the floor to prevent moisture migration.

C. General requirements and items common to more than one section of Division 22. Section 220500 General Plumbing Requirements.

D. Vacuum Piping and Equipment: Section 226113, Vacuum Systems For Laboratory And Healthcare Facilities

1.3 QUALITY ASSURANCE

A. Materials and Installation: In accordance with NFPA 99, and as specified.

B. Equipment Installer: Show technical qualifications and previous experience in installing healthcare equipment on three similar projects. Submit names and addresses of referenced projects.

C. Equipment Supplier: Show evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years. Submit names and addresses where the product is installed.

D. Healthcare System Testing Organization: The testing shall be conducted by a party technically competent and experienced in the field of healthcare pipeline testing. Such testing shall be performed by a party other than the installing contractor.

E. Provide names of three projects where testing of medical gases systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.

F. Submit the testing agency's detailed procedure which will be followed in the testing of

this project. Include details of the testing sequence, procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.

G. Certification: Provide documentation prior to submitting request for final inspection to include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits allowed by this specification.

H. Installing contractor shall maintain as-built drawings of each completed phases for verification; and, shall provide the complete set at the time of final systems certification testing, for certification by the Third-Party Testing Company. As-built drawings are to be provided, and a copy of them on Auto-Cad version 2013 or later) provided on compact disk or electronic format. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

1.4 SUBMITTALS

A. Submit as one package in accordance with Section 220500 General Plumbing Requirements.

B. Manufacturer's Literature and Data:

1. Piping.
2. Valves.
3. Inlet and outlet cocks
4. Valve cabinets.
5. Gages.
6. Alarm controls and panels.
7. Pressure Switches.
8. Manifolds.

C. Station Outlets: Submit letter from manufacturer stating that outlets are designed and manufactured to comply with NFPA 99. Outlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation. In lieu of above labels, certificate may be submitted by a nationally recognized independent testing laboratory, satisfactory to the Contracting Officer, certifying that materials, appliances and assemblies conform to published standards, including methods of tests, of above organizations.

D. Certification: The completed systems have been installed, tested, purged and analyzed in accordance with the requirements of this specification.

1.5 TRAINING

A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the healthcare gas systems, on the dates requested by Owner's personnel.

B. Coordinate with other requirements specified in Section 220500 General Plumbing Requirements.

1.6 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the test by the basic designation only.

B. American National Standards Institute (ANSI):

A13.1-96	Scheme for Identification of Piping Systems
B16.22-01	Wrought Copper and Bronze Solder-Joint Pressure Fittings
B40.1-98	Pressure Gauges and Gauge Attachments

C. American Society for Testing and Materials (ASTM):

B819-00	Standard Specification for Seamless Copper Tube for Medical Gas Systems

D. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code -

Section VIII-04	Pressure Vessels, Division I
Section IX-04	Welding and Brazing Qualifications

E. American Welding Society (AWS):

AWS A5.8-92	Brazing Filler Metal
AWS B2.2-91	Standard for Brazing Procedure and Performance Qualification (Modified per NFPA 99)

F. Compressed Gas Association (CGA):

C-9-04	Standard Color Marking of Compressed Gas Cylinders
G-4.1-96	Cleaning Equipment for Oxygen Service
G-10.1-97	Nitrogen, Commodity
P-9-92	Inert Gases Argon, Nitrogen and Helium
V-1-03	Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections

G. National Electrical Manufacturers Association (NEMA):

ICS-6-01	Industrial Controls and Systems Enclosures

H. National Fire Protection Association (NFPA):

99	Health Care Facilities Latest Edition

I. United States Pharmacopoeia XXI/National Formulary XVI (USP/NF)

J. Manufacturing Standardization Society (MSS):

MSS-SP-72-99	Ball Valves With Flanged or Butt Welding For General Purpose

MSS-SP-110-96	Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends
MSS-SP-73-03	Brazing Joints for Copper and Copper Alloy Solder Pressure Fittings
MSS-SP-69	Pipe Hangers and Supports – Selection and Application
MSS-SP-58	Pipe Hangers and Supports Materials, Design and Manufacturers Selection, Application and Installation

PART 2 - PRODUCTS

2.1 PIPING

A. Copper Tubing: Type "K" (3” diameter and larger) or "L" (smaller than 3” diameter), ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ANSI B16.22 or brazing fittings complying with MSS SP-73. Size designated reflecting nominal inside diameter. All tubing and fittings shall be labeled per NFPA 99 requirements.

B. Brazing Alloy: AWS A5.8, Classification BCuP, greater than 537 °C (1000 °F) melting temperature. Flux is strictly prohibited for copper-to-copper connections.

C. Screw Joints: Polytetrafluoroethylene (teflon) tape.

D. Underground Protective Pipe: Polyvinyl Chloride (PVC), ASTM D1785, Schedule 80.

E. Memory metal couplings having temperature and pressure rating not less than that of a brazed joint shall be permitted.

F. Apply piping identification labels shall be done at time of installation in accordance with current NFPA. Supplementary color identification shall be in accordance with CGA Pamphlet C-9.

2.2 HEALTHCARE GASES PIPING

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed healthcare gas piping.

1. Pipe: Fed. Spec. WW-P-351, standard weight.

2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).

3. Nipples: ASTM B 687, Chromium-plated.

4. Unions: MSS SP-72, SP-110, Brass or Bronze with chrome finish. Unions 2-1/2 inches and larger shall be flange type with approved gaskets.

5. Valves: MSS SP-72, SP-110, Brass or bronze with chrome finish.

2.3 VALVES

A. Ball: In-line, other than zone valves in cabinets:

1. 2 1/2 inches and smaller: Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110, Type II, Class 150, Style 1, with tubing extensions for brazed connections, full ported, three-piece or double union end connections, teflon seat seals, full flow,

600 psi WOG minimum working pressure, with locking type handle and cleaned for oxygen service. An acceptable manufacturer that meets the specification: Amico and Ohio Medical.

2. 3-4 inches: Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full ported, three piece, double seal, teflon seals, full flow, 600 psi WOG minimum working pressure, with locking type handle, and cleaned for oxygen service.

B. Check:

1. 3 inches and smaller: brass and Bronze body, straight through design for minimum pressure drop, spring loaded, self-aligning with teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into, cleaned for oxygen use, 400 psi WOG minimum working pressure.

C. Zone Valve in Cabinet: Ball valve, bronze/ brass body, double seal, three piece or double union end connections, replaceable teflon seat seals, teflon stem seal,600 psi WOG, cold, non-shock gas working pressure service to 29-inch Hg, cleaned for oxygen service, blowout proof stem, one quarter turn of handle to completely open or close. Provide tubing extensions factory brazed, pressure tested, cleaned for oxygen service. Provide 1/8 inch NPT gauge port for a 2-inch diameter monitoring gauge downstream of the shut off valve. Zone valves shall be securely attached to the cabinet and provided with type-K copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color coded stick-on labels. Install valves in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels is as follows:

SERVICE LABEL	IDENTIFICATION COLORS	MFG. STD. CLR.
OXYGEN	White letters on green background	GREEN
VACUUM	Black letters on white background	WHITE
MEDICAL AIR	Black letters on yellow background	YELLOW

2.4 VALVE CABINETS

A. Flush mounted commercially available item for use with healthcare services, not lighter than 18 gage steel or 14 gage extruded aluminum, rigidly assembled, of adequate size to accommodate valve(s) and fittings. Punch or drill sides to receive tubing. Provide anchors to secure cabinet to wall construction. Seal openings in cabinet to be substantially dust tight. Locate bottom of cabinet approximately 4 foot 6 inches above floor.

B. Mount engraved rigid plastic identification plate on wall above or adjacent to cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate must be clearly visible at all times. Provide inscriptions on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS."

C. Cover plate: Fabricate from 8 gage sheet metal with satin chromed finish, extruded anodized aluminum, or 22 gage stainless steel. Provide cover window of replaceable

plastic, with a corrosion resistant device or lever secured to window for emergency window removal. Permanently paint or stencil on window: "FOR EMERGENCY SHUT-OFF VALVES ONLY, SHUT-OFF VALVES FOR PIPED GASES", or equivalent wording. Configure such that it is not possible to install window with any valve in the closed position. Each valve shall have gauge upstream of valve inside valve box.

D. Cabinets and isolation valves shall be located and piped as shown, and at a minimum, so as to allow the isolation of each smoke compartment separately. No cabinet shall serve more than one smoke compartment.

2.5 GAGES

A. Pressure Gages: Includes gages temporarily supplied for testing purposes.

1. For line pressure use adjacent to source equipment: ANSI B40.1, pressure gage, single, size 4-1/2 inches, for compressed air, nitrogen and oxygen, accurate to within two percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on a white background, or white on a black background. Gage shall be cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Install with gage cock.

2. For all services downstream of main shutoff valve: Manufactured expressly for oxygen use but labeled for appropriate service and marked "USE NO OIL", 1-1/2 inch diameter gage with dial range 1-100 psi for air service, and 1-300 psi nitrogen service.

2.6 STATION OUTLETS

A. Refer to Equipment Plans.

2.7 STATION OUTLET ROUGH-IN

A. Flush mounted, protected against corrosion. Anchor rough-in securely to unit or wall construction.

B. Modular Cover Plate: Die cast plate, two-piece 22 gage stainless steel or 16 gage chromium plated metal, secured to rough-in with stainless steel or chromium plated countersunk screws.

C. Cover Plate for Prefabricated Bedside Patient Units (PBPU): One-piece with construction and material as indicated for modular cover plate.

D. Provide permanent, metal or plastic, identification plates securely fastened at each outlet and inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

SERVICE LABEL	IDENTIFICATION PLATE COLORS
OXYGEN	White letters on green background
VACUUM	Black letters on white background
MEDICAL AIR	Black or white letters on yellow

2.8 ALARMS

A. Provide all low voltage control wiring, except for wiring from alarm relay interface control cabinet required for a complete and proper functioning system. Run wiring in conduit.

B. Local Alarm Functions: Provide individual local air compressor malfunction alarms at each compressor system main control panel.

1. Compressor Malfunction Alarm: Each compressor system receiving any of the following individual signals and sends a single combined "compressor malfunction alarm" signal to master alarm panel.

a. Thermal Malfunction Alarm: Functions when discharge air temperature exceeds 350 °F, shutting down affected compressor.

b. Lead Compressor Fails to Start: Functions when lead compressor fails to start when actuated, causing lag pump to start.

c. Lag Compressor in Use: Functions when lag compressor starts.

d. High Water Level in Receiver. (Liquid ring unit)

e. High Water Level in Separator (if so required). (Liquid ring unit)

2. Desiccant Air Dryer Malfunction Alarm: Dryer receives the following individual signals and sends a single consolidated dryer malfunction alarm signal to master alarm panel.

a. Dew Point Alarm: Functions when pressure dew point rises above 39 °F at 55 psi.

3. Vacuum Pump Malfunction Alarm: Pump system receives the following individual signals and sends a single consolidated pump malfunction alarm signal to master alarm.

a. High Temperature Shut down Alarm: Functions when exhaust air temperature exceeds 220 °F, shutting down affected pump.

b. Lead Pump Fails to Start Alarm: Functions when lead pump fails to start when actuated causing lag pump to start.

c. Lag Pump In Use Alarm: Functions when lag pump starts.

C. Master Alarm Functions: Provide the following individual alarms at the master alarm panel.

1. Oxygen Alarms:

a. Liquid oxygen low level alarm: Functions when stored liquid oxygen reaches a predetermined minimum level.

b. Reserve switchover alarm: Functions when reserve oxygen supply goes in operation.

c. Reserve low supply alarm: Functions when contents of cylinder reserve oxygen supply are reduced to one day's average supply; switch and contacts at the bulk tank control panel.

d. Reserve low pressure alarm: Functions when the gas pressure available in the liquid reserve oxygen supply is reduced below the pressure required to function properly.

e. Low pressure alarm: Functions when system pressure downstream of the main shutoff valve drops below 40 psi, plus/minus two psi; operated by pressure switch or transmitters.

f. High pressure alarm: functions when system pressure downstream of main shutoff valve increases above 60 psi, plus/minus set points; operated by pressure switches or transmitters.

2. Compressed Air Alarms:

a. Dew point alarm: Functions when pressure dew point rises above 39 °F at 55 psi.

b. Carbon Monoxide Alarm: Functions when the carbon monoxide levels rise above 10 parts per million; receives signal from the carbon monoxide monitor.

c. Main Bank Filter Set Alarm: Functions when the pressure drop across filter set increases more than two psi over that when filters are clean and new; operates by differential pressure switch or transmitters.

d. Desiccant Prefilter Alarm: Functions when pressure across the filter increases more than three psi over that when filters are clean and new; operates by pressure differential switch.

e. Desiccant Post Filter Alarm: Functions when pressure drop across filter increases more than 3 psi over that when filters are clean and new; operates by pressure differential switch.

f. Desiccant Dryer Malfunction Alarm: Functions on any combination of failure of tower cycling and/or pressure dew point rise above 140 degrees F at 100 psi.

g. Aftercooler High Temperature Alarm: Functions when aftercooler discharge air temperature exceeds 100 degrees F.

h. Pressure Abnormal Alarm: Functions when system pressure downstream of main shutoff valve drops below 80 psi plus/minus 2 psi or increases above 120 psi plus/minus 2 psi set points; operated by pressure switch.

i. Compressor Malfunction Alarm: Functions when compressor system control panel signals compressor thermal malfunction alarm, lead compressor fails to start alarm or high water level in receiver or separator (if so required) receives signal from system control panel.

j. Low Lubricant Shutdown: For rotary screw compressors. Functions when lubricant level drops to a low point. Receives signal from compressor control panel.

D. Area Alarm Functions:

1. Oxygen and compressed air alarms: Pressure alarms: Functions when pressure in branch drops below 40 psi, plus/minus two psi or increases above 60 psi,

plus/minus two psi set points; operated by pressure switches or transmitters.

2. Vacuum alarms: Low vacuum alarm: Functions when vacuum in branch drops below 12-inches Hg; operated by vacuum switch.

3. Vacuum alarms:

   a. Low vacuum alarm: Function when system vacuum upstream of main shutoff valve drops below 12 inches Hg; operated by vacuum switch.

   b. Filter differential pressure/back pressure alarm: Functions when discharge oil filter differential rises to set level, or when back pressure is sensed; receives signal from pump control panel.

   c. Vacuum pump malfunction.

E. Alarm Panels:

1. General: Modular design, easily serviced and maintained; alarms operate on alternative current low voltage control circuit; provide required number of transformers for efficient functioning of complete system. Alarm panels shall be integral units, reporting oxygen, nitrous oxide and nitrogen compressed air and vacuum services, as required.

2. Box: Flush mounted, sectional or one piece, corrosion protected. Size to accommodate required number of service functions for each location, and for one audible signal in each box. Anchor box securely.

3. Cover plate: Designed to accommodate required number of signals, visual and audible, for each location, and containing adequate operating instructions within the operator's view. Bezel shall be extruded aluminum, chromium plated metal, or plastic. Secure to the box with chromium plated or stainless steel countersunk screws.

4. Service indicator lights: Red translucent plastic or LED with proper service identification inscribed thereon. Number of lights and service instruction shall be as required for each location. Provide each panel with a green test button of the same material, inscribed with "PUSH TO TEST" or similar message.

5. Audible signal: Provide one in each alarm panel and connect electrically with all service indicator light functions.

6. Controls:

   a. Visual signal: When the condition occurs which any individual service indicator light is to report, button for particular service shall give a lighted visual signal which cannot be canceled until such condition is corrected.

   b. Audible signal: Alarm shall give an audible signal upon circuit energization of any visual signal. Audible signal shall be continuous until silenced by pushing a button. This shall cancel and reset audible only, and not affect the visual signal. After silencing, subsequent alarms shall reactivate the audible alarm.

   c. Signal tester: Test button or separate normal light shall be continuously lighted to indicate electrical circuit serving each individual alarm is

energized. Pushing test button shall temporarily activate all visual signals and sound audible signal, thereby providing desired indications of status of system.

F. Alarm Network Communication: Network communications board shall be installed in local alarm and connected to the facility's Ethernet. Local alarm modules can send information to the master alarm and the data can be down loaded thru the computer which connected to the facility's Ethernet. Master alarm displays the message, sound its alarm and save the information in an event log. This event log can be down loaded to a computer file for tracking data and troubleshooting.

2.9 PRESSURE SWITCHES

A. General purpose, contact or mercury type, allowing both high and low pressure set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Use one orifice nipple (or DISS demand check valve) for each sensor or pressure switch.

2.10 NITROGEN CONTROL PANEL (NCP)

A. Not Used.

2.11 CYLINDER GAS SUPPLY MANIFOLDS

A. Non-ferrous metal manifold and fittings, valves, parts and connections, suitable for a regular working pressure of 3000 psi. Gas cylinders at manifold shall be individually chained to wall or floor with adequate support.

B. Duplex arrangement, each bank having number of cylinder connections as required, high pressure copper cylinder connection pigtails with brazed fittings. Shutting of either bank shall not interrupt supply to system.

C. Switch-over to full reserve bank shall be automatic when one cylinder bank becomes exhausted, with no fluctuation in pressure, and not require resetting of regulators. After replacement of empty tank, resetting of controls shall be automatic or by single lever. Reserve switch-over shall be actuated by pressure switch; alarm shall be part of manifold control.

2.12 PRESSURE REGULATORS:

A. For 100 psi regulator, provide duplex in parallel, valve for maintenance shut-down without service interruption. For additional pressures, locate regulators remote from compressor near point of use, and provide with isolation valves and valve bypass.

1. For systems 10 scfm and below: Brass or bronze body and trim, reduced pressure range 25 – 125 psi adjustable, spring type, diaphragm operated diaphragm operated, relieving. Delivered pressure shall vary not more than onepsi for each 10 psi variation in inlet pressure.

2.13 EMERGENCY LOW PRESSURE OXYGEN INLET

A. The Low-Pressure Emergency Oxygen Inlet provides an inlet for connecting a temporary auxiliary source of oxygen to the oxygen pipeline system for emergency or maintenance situations per NFPA 99.

B. The inlet consists of a 1" ball valve, pressure gauge and a 1/2"/1" NPTF connection housed in a weather tight enclosure. The enclosure is labeled "Emergency Low Pressure

Gaseous Oxygen Inlet", and includes a padlock staple to prevent tampering or unauthorized access. The enclosure is suitable for recess mounting on the exterior of the building being served. The enclosure is 14 gauge, cold rolled steel with a primer coat of paint. The Emergency Oxygen Inlet is connected at a point downstream of the main supply line shutoff valve.

C. Check valves are provided for installation in the emergency supply line and 'in the main supply line between the main line shutoff valve and the emergency supply line connection per by NFPA 99. Check valves have a cast bronze body and straight through design for minimum pressure drop.

D. The check valves for sizes under 3" are soft seated, bubble tight, self-aligning, and spring loaded, and ball type check valves. Three-inch (76 mm) check valves are hard seated, spring loaded, self-aligning ball type checks with cone seats (3" valves may not be "bubble tight"). Check valves are fast acting.

E. A relief valve is provided for installation in the emergency supply line per NFPA 99. The relief valve has a brass body, single seat design, and is cleaned for oxygen use. It automatically reseats to provide a "bubble tight" seal after discharging excess gas. Pre-set at 75 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In accordance with current NFPA. Run buried oxygen piping in PVC protective pipe for entire length including enclosure of fittings and changes of direction.

B. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

C. Keep open ends of tube capped or plugged at all times or otherwise sealed until final assembly.

D. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, material is no longer suitable for oxygen service.

E. Spacing of hangers: Current NFPA.

F. Rigidly support valves and other equipment to prevent strain on tube or joints.

G. While being brazed, joints shall be continuously purged with *oil* free nitrogen. The flow of purged gas shall be maintained until joint is cool to touch.

H. Do not bend tubing. Use fittings.

K. Install pressure switches, transmitter and gauges to be easily accessed, and provide access panel where installed above plaster ceiling. Install pressure switch and sensors with orifice nipple between the pipe line and switches/sensors.

L. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.

M. Pipe compressor intake to a source of clean ambient air as indicated in current NFPA.

N. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.

O. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified, with intumescent materials only. Completely fill and seal clearances between raceways and openings with the fire stopping material.

2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified.

P. Provide 1 1/2-inch diameter line pressure gage downstream of zone valve in cabinets.

Q. Provide zone valves in cabinets where indicated and outside each Operating Room and a minimum one zone valve assembly for each 18-outlet set.

3.2 TESTS

A. Initial Tests: Blow down, and high and low pressure leakage tests as required by current NFPA with documentation.

B. Healthcare testing agency shall perform the following:

1. Perform and document all cross-connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with, current NFPA and the procedures set forth in pre-qualification documentation.

2. Verify that the systems, as installed, meet or exceed the requirements of current NFPA, this specification, and that the systems operate as required.

3. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 35 cubic feet of gas through a clean white 0.45-micron filter at a minimum velocity of 3.5 scfm (100 Lpm). Filter shall show no discoloration, and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9.

4. Piping purity test: For each positive pressure system, verify purity of piping system. Test each zone at the most remote outlet for dew point, carbon monoxide, total hydrocarbons (as methane), and halogenated hydrocarbons, and compare with source gas. The two tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Perform test with the use of an inert gas as described in CGA P-9.

5. Outlet and inlet flow test:

a. Test all outlets for flow. Perform test with the use of an inert gas as described in CGA P-9.

b. Oxygen, nitrous oxide and air outlets must deliver 3.5 scfm with a pressure drop of no more than 5 psi, and static pressure of 50 psi.

c. Nitrogen outlets must deliver 20 scfm with a pressure drop of no more than 5 psi, and static pressure of 210 psi.

d. Needle valve air outlets must deliver 1.5 scfm with a pressure drop of no more than five psi, and static pressure of 50 psi.

6. Source Contamination Test: Analyze each pressure gas source for concentration of contaminants, by volume. Take samples for air system test at the intake and at a point immediately downstream of the final filter outlet. The compared tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Allowable concentrations are below the following:

Dew point, air	35 degrees F pressure dew point at 100 psi
Carbon monoxide, air	10 mg/L (ppm)
Carbon dioxide, air	1000 mg/L (ppm)
Gaseous hydrocarbons as methane, air	5 mg/L (ppm)
Halogenated hydrocarbons, air	2 mg/L (ppm)

7. Analysis Test:

a. Analyze each pressure gas source and outlet for concentration of gas, by volume.

b. Make analysis with instruments designed to measure the specific gas dispensed.

c. Allowable concentrations are within the following:

1) Laboratory air 19.5 percent to 23.5 percent oxygen.

Oxygen	99 plus percent oxygen
Nitrous oxide	99 plus percent nitrous oxide
Nitrogen	99 plus percent nitrogen
Medical air	19.5 percent to 23.5 percent oxygen

8. Maximum Allowable Variation: Between comparative test results required are as follows:

Dew point	4 degrees F
Carbon monoxide	2 mg/L (ppm)
Total hydrocarbons as methane	1 mg/L (ppm)
Halogenated hydrocarbons	2 mg/L (ppm)

END OF SECTION 226000

SECTION 226113

VACUUM SYSTEMS FOR HEALTHCARE FACILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Central Healthcare Vacuum Systems: Consisting of vacuum and anesthesia evacuation services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets and inlets, rough-ins, ceiling services, gages, alarms including low voltage wiring, vacuum pumps, electric motors and starters, receivers, and all necessary parts, accessories, connections and equipment.

B. Vacuum system alarm wiring from equipment to alarm panels.

1.2 RELATED WORK

A. Sealing around pipe penetrations to maintain the integrity of time rated construction.

B. Sealing around pipe penetrations through the floor to prevent moisture migration.

C. General requirements and items common to more than one section of Division 22: Section 220500 General Plumbing Requirements.

D. Healthcare Gases and Vacuum Alarms: Section 226000, Gas Systems For Healthcare Facilities.

1.3 QUALITY ASSURANCE

A. Materials and Installation: In accordance with NFPA 99, and as specified.

B. Equipment Installer: Show technical qualifications and previous experience in installing medical gas equipment on three similar projects. Submit names and addresses of referenced projects.

C. Equipment Supplier: Show evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years. Submit names and addresses where the product is installed.

D. Medical Gas System Testing Organization: The testing shall be conducted by a party technically competent and experienced in the field of medical gas pipeline testing. Such testing shall be performed by a party other than the installing contractor.

E. Provide names of three projects where testing of vacuum systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.

F. Submit the testing agency's detailed procedure which will be followed in the testing of this project. Include details of the testing sequence, procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.

G. Certification: Provide documentation prior to submitting request for final inspection to

include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits allowed by this specification.

H. Installing contractor shall maintain as-built drawings of each completed phases for verification; and, shall provide the complete set at the time of final systems certification testing, for certification by the Third Party Testing Company. As-built drawings are to be provided, and a copy of them on Auto-Cad version (2013 or later) provided on compact disk. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

1.4 SUBMITTALS

A. Submit as one package in accordance with Section 220500, General Plumbing Requirements.

B. Manufacturer's Literature and Data:

1. Piping.
2. Valves.
3. Inlet and outlet cocks
4. Valve cabinets.
5. Gages.
6. Station inlets, and rough-in assemblies.
7. Alarm controls and panels.
8. Vacuum switches.

C. Station Inlets: Submit letter from manufacturer stating that inlets are designed and manufactured to comply with NFPA 99. Inlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation. In lieu of above labels, certificate may be submitted by a nationally recognized independent testing laboratory, satisfactory to the Contracting Officer, certifying that materials, appliances and assemblies conform to published standards, including methods of tests, of above organizations.

D. Certification: The completed systems have been installed, tested, purged and analyzed in accordance with the requirements of this specification.

1.5 TRAINING

A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the vacuum systems, on the dates requested by Owner's personnel.

B. Coordinate with other requirements specified in Division 22, General Requirements.

1.6 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the test by the basic designation only.

B. American National Standards Institute (ANSI):

A13.1-96 Scheme for Identification of Piping Systems

B16.22-01 Wrought Copper and Bronze Solder-Joint Pressure Fittings

B40.1-98 Pressure Gauges and Gauge Attachments

C. American Society for Testing and Materials (ASTM):

B819-00 Standard Specification for Seamless Copper Tube for Medical Gas Systems

D. American Society of Mechanical Engineers (ASME):

Section IX-04 Welding and Brazing Qualifications

E. American Welding Society (AWS):

AWS A5.8-92 Brazing Filler Metal

AWS B2.2-91 Standard for Brazing Procedure and Performance Qualification (Modified per NFPA 99)

F. Compressed Gas Association (CGA):

P-9-92 Inert Gases Argon, Nitrogen and Helium

G. National Electrical Manufacturers Association (NEMA):

ICS-6-01 Industrial Controls and Systems Enclosures

H. National Fire Protection Association (NFPA):

99 Health Care Facilities

I. United States Pharmacopoeia XXI/National Formulary XVI (USP/NF)

J. Manufacturing Standardization Society (MSS):

MSS-SP-72-99 Ball Valves With Flanged or Butt Welding For General Purpose

MSS-SP-110-96 Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

MSS-SP-73-03 Brazing Joints for Copper and Copper Alloy Solder Pressure Fittings

MSS-SP-69 Pipe Hangers and Supports – Selection and Application

MSS-SP-58-2009 Pipe Hangers and Supports Materials, Design and Manufacturers Selection, Application and Installation

PART 2 - PRODUCTS

2.1 PIPING

A. Copper Tubing: Type "K" or "L", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ANSI B16.22 or brazing fittings complying with MSS SP-73. Size designated reflecting nominal inside diameter. All tubing and fittings shall be labeled per NFPA 99 requirements.

B. Brazing Alloy: AWS A5.8, Classification BCuP, greater than 537 °C (1000 °F) melting

temperature. Flux is strictly prohibited for copper-to-copper connections.

C. Screw Joints: Polytetrafluoroethylene (teflon) tape.

D. Galvanized Steel: Use only for discharge from vacuum producer.

1. Pipe: ASTM A53, standard weight.

2. Fittings:

a. Flexible groove, malleable iron, ASTM A47, or ductile iron, ASTM A536.

b. Malleable iron screwed, ANSI B16.3.

E. Memory metal couplings having temperature and pressure rating not less than that of a brazed joint shall be permitted.

F. Apply piping identification labels shall be done at time of installation in accordance with current NFPA. Supplementary color identification shall be in accordance with CGA Pamphlet C-9.

2.2 EXPOSED LABORATORY AND HEALTHCARE VACUUM PIPING

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed laboratory and healthcare vacuum piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.

1. Pipe: Fed. Spec. WW-P-351, standard weight.

2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).

3. Nipples: ASTM B 687, Chromium-plated.

4. Unions: MSS SP-72, SP-110, Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

5. Valves: MSS SP-72, SP-110, Brass or bronze with chrome finish.

2.3 VALVES

A. Ball: In-line, other than zone valves in cabinets.

1. 2 1/2 inches and smaller: Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110, Type II, Class 150, Style 1, with tubing extensions for brazed connections, full ported, three-piece or double union end connections, teflon seat seals, full flow, 600 psi WOG minimum working pressure, with locking type handle. An acceptable manufacturer that meets the specifications: Amico and Ohio Medical.

2. 3-4 inches: Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full ported, three piece, double seal, teflon seals, full flow, 600 psi WOG minimum working pressure, with locking type handle.

B. Check:

1. 3 inches and smaller: brass and Bronze body, straight through design for

minimum pressure drop, spring loaded, self aligning with teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into, 400 psi WOG minimum working pressure.

C. Zone Valve in Cabinet: Ball valve, bronze/ brass body, double seal, three piece or double union end connections, replaceable teflon seat seals, teflon stem seal, 600 psi WOG, cold, non-shock gas working pressure or vacuum service to 29-inch Hg, blowout proof stem, one quarter turn of handle to completely open or close. Provide tubing extensions factory brazed, pressure tested, cleaned for oxygen service. Provide 1/8 inch NPT gauge port for a 2-inch diameter monitoring gauge downstream of the shut off valve. Zone valves shall be securely attached to the cabinet and provided with type-K copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color-coded stick-on labels. Install valves in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels is as follows:

SERVICE LABEL	IDENTIFICATION COLORS	MFG. STD. CLR.
MEDICAL VACUUM	Black letters on white background	WHITE
Evacuation (Waste Gas)	White letters on violet background	PURPLE

2.4 VALVE CABINETS

A. Flush mounted commercially available item for use with medical gas services, not lighter than 18 gage steel or 14 gage extruded aluminum, rigidly assembled, of adequate size to accommodate valve(s) and fittings. Punch or drill sides to receive tubing. Provide anchors to secure cabinet to wall construction. Seal openings in cabinet to be substantially dust tight. Locate bottom of cabinet approximately 4 foot 6 inches above floor.

B. Mount engraved rigid plastic identification plate on wall above or adjacent to cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate must be clearly visible at all times. Provide inscriptions on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS."

C. Cover plate: Fabricate from 18 gage sheet metal with satin chromed finish, extruded anodized aluminum, or 22 gage stainless steel. Provide cover window of replaceable plastic, with a corrosion resistant device or lever secured to window for emergency window removal. Permanently paint or stencil on window: "FOR EMERGENCY SHUT-OFF VALVES ONLY, SHUT-OFF VALVES FOR PIPED GASES", or equivalent wording. Configure such that it is not possible to install window with any valve in the closed position. Each valve shall have gauge upstream of valve inside valve box.

D. Cabinets and isolation valves shall be located and piped as shown, and at a minimum, so as to allow the isolation of each smoke compartment separately. No cabinet shall serve more than one smoke compartment.

2.5 GAGES

A. Vacuum Gages:

1. For vacuum line use adjacent to source equipment: ANSI B40.1, vacuum gage, size 4-1/2 inches, gage for air, accurate to within two percent, with metal case. Range shall be 0-30 inches Hg. Dial graduations and figures shall be black on a white background, or white on a black background. Label for vacuum service. Install with gage cock. Provide compound gages for Vacuum system.

2. For vacuum service upstream of main shutoff valve: Provide 1-1/2 inch diameter gage with steel case, bourdon tube and brass movement, dial range 0-30 inches Hg. Provide compound gages for Vacuum system.

2.6 STATION INLET ROUGH-IN

A. Flush mounted, protected against corrosion. Anchor rough-in securely to unit or wall construction.

B. Modular Cover Plate: Die cast plate, two-piece 22 gage stainless steel or 16 gage chromium plated metal, secured to rough-in with stainless steel or chromium plated countersunk screws.

C. Cover Plate for Prefabricated Bedside Patient Units (PBPU): One-piece with construction and material as indicated for modular cover plate.

D. Provide permanent, metal or plastic, identification plates securely fastened at each inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

SERVICE LABEL	IDENTIFICATION PLATE COLORS
MEDICAL VACUUM	Black letters on white background
EVACUATION (Waste Gas)	White letters on violet background

2.10 VACUUM SWITCHES

A. General purpose, contact or mercury type, allowing both high and low set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Use one orifice nipple (or DISS demand check valve) for each sensor switch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In accordance with current NFPA 99, latest edition.

B. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

C. Keep open ends of tube capped or plugged at all times or otherwise sealed until final assembly.

D. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, material is no longer suitable for oxygen service.

E. Spacing of hangers: Current NFPA.

F. Rigidly support valves and other equipment to prevent strain on tube or joints.

G. While being brazed, joints shall be continuously purged with *oil* free nitrogen. The flow of purged gas shall be maintained until joint is cool to touch.

H. Do not bend tubing. Use fittings.

I. Support ceiling column assembly from heavy sub-mounting castings furnished with the unit as part of roughing-in. Anchor with 1/2-inch diameter bolts attached to angle iron frame supported from structural ceiling, unless otherwise indicated.

J. Install pressure and vacuum switches, transmitter and gauges to be easily accessed, and provide access panel where installed above hard ceiling. Install pressure switch and sensors with orifice nipple between the pipe line and switches/sensors.

K. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.

L. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.

M. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases, with intumescent materials only. Completely fill and seal clearances between raceways and openings with the fire stopping material.

2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant.

N. Provide 1 1/2-inch diameter line vacuum gage downstream of zone valve in cabinets.

O. Provide zone valves in cabinets where indicated and outside each Operating Room and a minimum one zone valve assembly for each 18-outlet set.

3.2 TESTS

A. Initial Tests: Blow down, and high and low pressure leakage tests as required by current NFPA with documentation.

B. Medical gas testing agency shall perform the following:

1. Perform and document all cross-connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with, current NFPA and the procedures set forth in pre-qualification

documentation.

2. Verify that the systems, as installed, meet or exceed the requirements of current NFPA, this specification, and that the systems operate as required.

3. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 35 cubic feet of gas through a clean white 0.45 micron filter at a minimum velocity of 3.5 scfm. Filter shall show no discoloration, and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9.

4. Inlet flow test:

   a. Test all inlets for flow. Perform test with the use of an inert gas as described in CGA P-9.

   b. Needle valve vacuum inlets must draw no less than 1.0 scfm with adjacent inlet flowing, at a dynamic inlet pressure of 12-inches Hg, and a static vacuum of 15-inches Hg.

   c. Vacuum inlets must draw no less than 3.0 scfm with adjacent inlet flowing, at a dynamic inlet pressure of 12-inches Hg, and a static vacuum of15-inches Hg.

   d. Anesthesia evacuation inlets must draw no less than 1.0 scfm at a dynamic inlet pressure of 12-inches Hg, and a static vacuum of 15-inches Hg.

END OF SECTION 226113

SECTION 26 0519 – LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.0 SECTION INCLUDES

A. Building wire (600 V)

B. Metal-clad cable (600 V)

C. Wire and cable connectors

D. Insulating tape and tubing

E. Wire pulling lubricant

1.1 QUALITY ASSURANCE

A. Comply with the National Electrical Code (NEC) for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

1.2 SUBMITTALS

A. Submit the following in accordance with the provisions of Section 01 3000 Submittal Procedures:
   1. Catalog Data: Compression connectors; indicate installation tools and dies that will be used.

1.3 PROJECT RECORD DOCUMENTS

A. Submit the following in accordance with the provisions of Section 01 7000 Execution and Closeout Procedure.

   1. Field Test Records:
      a. Cable pulling records required in Building Wire Installation.
      b. Inspections and tests required in Field Quality Control.

1.4 RECEIVING, STORING AND PROTECTING

A. Receive, store, and protect, and handle products according to NECA 1, Standard Practices for Good Workmanship in Electrical Construction.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to Section 01 3000 Substitution Procedures.

2.2 BUILDING WIRE

A. Provide NRTL-listed building wire as shown on the Drawings with the following characteristics:
   1. Description: Single conductor 600 V insulated wire.

   2. Conductor:
      a. Unless otherwise indicated on the Drawings: 98% conductivity, annealed, uncoated copper, ASTM B 3 Standard Specification for Soft or Annealed Copper Wire, solid or stranded as specified in Part 3 of this Section.

   3. Insulation: The following types, rated 600 volts:
      a. Unless otherwise indicated on the Drawings: 1 AWG and smaller, Type THHN/THWN-2 per UL Standard 83, “Thermoplastic-Insulated Wires and Cables.”
      b. Where indicated on the Drawings: 1 AWG and smaller, Type XHHW-2 per UL Standard 44, “Thermoset-Insulated Wires and Cables.”
      c. 1/0 AWG and larger, Type XHHW-2 per UL Standard 44, “Thermoset-Insulated Wires and Cables.
      d. Where noted on the Drawings:
         1. #12 – 3 Conductor Houston Wire and Cable cat # HW155-12014
         2. #500 KCMIL Single Conductor CU Cable Okonite FMR- N cat# 112-17-153.

B. Color code conductors as follows:
   1. Use colored insulation for color coding conductors 6 AWG and smaller.

   2. Use water and oil resistant colored plastic adhesive tape, 3/4-inch minimum width, for color coding conductor 4 AWG and larger. Manufacturer: 3M “Scotch 35"

   3. Provide black conductor insulation where colored tape is used for color coding.

4. Use the following color codes for AC power system conductors:

System Voltage: Conductor:	480Y/277V	208Y/120V	208Y/120V Isolated Ground	120/240V
Phase A:	Brown	Black	Black	Black
Phase B:	Orange	Red	Red	Red
Phase C:	Yellow	Blue	Blue	---
Grounded (Neutral):	Gray	White	White White/Red*	White White/Blue*
Equipment Grounding:	Green	Green	Green	Green
Isolated Ground:	---	---	Green/Yellow	---
Switched:	Purple	Pink	---	Blue

* Provide grounded conductor insulation with colored stripe when installed in any raceway, box, or enclosure with wiring of another system voltage.

5. Use the following color codes for DC power system conductors:
   Positive: Red
   Negative: Black

6. Provide color code for control conductors as indicated on equipment or control system manufacturer's drawings.

2.3 METAL-CLAD CABLE

A. Provide metal-clad cable (Type MC) that complies with UL Standard 1569 – Metal-Clad Cables, the NEC, and this Section.

B. Metal-clad cable shall consist of 600 V THHN insulated solid copper circuit conductors, an insulated solid copper equipment grounding conductor, a Mylar wrapping around the conductor bundle, and a close-fitting aluminum or galvanized steel outer sheath.

C. Provide MC cables with quantities and sizes (minimum 12 AWG) of conductors as indicated on the Drawings.

1. Provide larger conductor sizes as required to limit branch circuit voltage drop to 3 percent at the full connected load.

2. Use larger conductor sizes to adjust allowable ampacity if there are more than 3 current-carrying conductors in a cable.

3. For isolated ground power circuits provide Type MC cables with a separate neutral conductor and isolated ground conductor for each circuit; uniquely identify each neutral with a colored stripe on the white insulation corresponding to the phase conductor insulation color.

D. Provide MC cables with the same conductor color coding as specified for BUILDING WIRE.

E. Metal-clad cable manufacturer: AFC Cable Systems Inc.

F. Provide NRTL Listed, insulated throat or insulating bushing, connectors for Type MC Cables. Manufacturers: Arlington Industries "SNAP2IT." O-Z/Gedney ETP "Speed-Lock," "AMC," "KC," or PK as appropriate for MC Cable diameter.

2.4 WIRING CONNECTORS

A. For splices and taps on copper wire, sizes 20 to 12 AWG solid and 16 to 14 AWG stranded, use push-on, insulated, spring type connectors, rated 600 V and 105 ºC that are NRTL-listed to UL 486C Splicing Wire Connectors and provide a means of visual inspection of the connection. Manufacturer: IDEAL "In-Sure."

B. For splices and taps on copper wire, sizes 8 AWG and smaller, use insulated, spring type connectors, rated 600 volts and 105 ºC that are NRTL-listed to UL 486C, Splicing Wire Connectors. Manufacturer: 3M "Scotchlok."

C. For splices and taps on copper wire, sizes 6 AWG through 1 AWG, use the following materials:

1. Tin-plated copper split-bolt connectors that meet the requirements in UL 486A-486B, Wire Connectors; provide with matching 600-volt snap-on insulating cover. Manufacturer: FCI Burndy "Type KSA" with "Type SC" insulating cover.

2. Multi-tap connectors that meet the requirements of UL 486A-466B that have two or more range-taking mechanical lugs and matching 600-volt insulated cover. Manufacturers: Burndy 'POLYTAP" or "UNITAP", Ilsco "Type PCT", Blackburn "AMT".

D. For copper wire, sizes 1/0 AWG and larger, use UL 486A-486B listed circumferential or hexagonal crimp compression terminals, splices, or adapters.

1. Provide compression terminals and splices made from electro-tin plated seamless copper tubing and marked with wire size, die index / color code, and number / locations of crimps. Manufacturers: FCI Burndy Types "YA", "YA-L", "YA-L-NT", "YS", and "YC-C." Thomas & Betts "Color-Keyed."

2. Provide straight and offset compression adapters made from electro-tin-plated aluminum, NRTL listed for use on copper conductors, and marked with wire size, die index / color code, and number / locations of crimps. Each adapter shall include a 600 V, 90-degree C rated insulating cover. Manufacturer: FCI Burndy Types "AYP" and "AYPO."

3. Range-taking, die-less, or indenter-applied terminals are not acceptable.

E. For control wiring use nylon insulated crimp-on terminals with insulation grip that meet the requirements of UL 486A-486B. Manufacturer: 3M "Scotchlok MNG," Thomas & Betts "Sta-Kon."

1. Use ring tongue terminals for nutted studs.

2. Use flanged fork terminals for barrier terminal blocks.

3. Use pin terminals or ferrules for DIN type terminal blocks.

F. Insulation-piercing type connectors are not acceptable for power or control wiring.

2.5 INSULATING TAPE AND TUBING

A. For making re-enterable tape-insulated splices and connections, provide varnished cambric electrical insulating tape made of cotton cambric fabric that is oil primed and coated with electrical insulating varnish. Manufacturer: 3M "Scotch 2510" (no adhesive) and Scotch 2520" (pressure-sensitive adhesive).

B. Insulate taped splices and connections using ethylene propylene rubber (EPR) tape that meets the requirements of UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape and is rated for 90 ºC continuous operation and 130 ºC short-term overload service. Manufacturer: 3M "Scotch 130C"

C. For the outer covering of tape-insulated splices and connections use vinyl plastic tape that meets the requirements of UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape and has the following characteristics:

1. 8.5 mil minimum thickness,

2. ASTM D-3005, "Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape – Type 1."

3. Rated 600 volts and 105 ºC, suitable for indoor and outdoor applications.

4. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100 ºF without loss of physical or electrical properties.

5. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight.

6. Manufacturer: 3M "Scotch Super 88"

D. Provide heat shrinkable tubing that meets the requirements of UL 486D – Sealed Wire Connector Systems and has the following characteristics:

1. Rated 600 volts
2. Factory applied adhesive/sealant
3. Split resistant

4. Manufacturer: 3M “ITCSN”

E. Use motor lead splicing kits to insulate and seal connections to leads for motors rated 480V and less. Manufacturer: 3M “5300 Series”

2.6 WIRE PULLING LUBRICANT

A. Provide NRTL-listed wire pulling lubricant that is compatible with the conductor insulation or jacket, has a maximum coefficient of dynamic friction of 0.25, and leaves no flammable residue. For cold weather installations, provide wire pulling lubricant suitable for conduit temperature.

B. Compatibility with conductor insulation shall be determined in accordance with IEEE Standard 1210, Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.

C. Manufacturer:

1. For conduit temperature above freezing: Polywater “Lubricant J.”
2. For conduit temperature below freezing: Polywater “Lubricant WJ.”

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify interior of building has been protected from weather.

B. Verify that work of other trades likely to damage wire and cable is completed.

C. Verify raceway installation is complete and supported.

D. Verify that field measurements are as shown on Drawings.

E. Wire and cable routing shown on Drawings is approximate unless dimensioned.

1. Route wire and cable as required meeting project conditions.
2. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required to meet Project conditions.

3.2 PREPARATION

A. Examine raceways and building finishes that are to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Completely and thoroughly swab raceway before installing wire.

C. Do not handle or pull cables that are colder than +14 degrees F. Store cold cables for at least 24 hours in a heated building prior to installation.

3.3 BUILDING WIRE INSTALLATION

A. Install building wire according to, the NEC, the requirements in this Section, and the following NECA installation standards as applicable:

1. NECA 1 Standard for Good Workmanship in Electrical Construction (ANSI).

B. Do not damage conductor, insulation, or jacket by excessive installation pulling tension or sidewall bearing pressure.

1. Calculate expected cable pulling tension and sidewall bearing pressures for each set of conductors being pulled into a conduit run where any of the following combinations of bends and raceway length is exceeded between accessible pull points:
   a. 4 equivalent 90-degree bends and 10 feet of raceway.
   b. 3 equivalent 90-degree bends and 40 feet of raceway.
   c. 2 equivalent 90-degree bends and 80 feet of raceway.
   d. 1 equivalent 90-degree bend and 150 feet of raceway.
   e. Straight pull with more than 250 feet of raceway.

2. For cable pulling tension and sidewall bearing pressure calculations use formulas and factors described in IEEE Standard 422, IEEE Guide for the Design and Installation of Cable Systems in Power Generating Stations.

3. Obtain recommended maximum conductor or cable pulling tension and sidewall bearing pressure values from the manufacturer, or use the following maximum allowable values:
   a. Maximum sidewall bearing pressure: 500 lb./ft.
   b. Maximum tension, pulling directly on conductor: 0.008 lb./cmil
   c. Maximum tension, pulling on basket grip over insulation jacket: 2000 lb., not to exceed 0.008 lb./cmil of conductor.

4. Use a tension measuring device to monitor pulling force on runs where cable pulling calculations indicate installation stresses may exceed 80 percent of allowable pulling tension or sidewall bearing pressure.
   a. Record the maximum measured pulling tension for each monitored cable pull.
   b. Submit the recorded cable pulling tension for each monitored cable pull and the corresponding calculated allowable pulling tension.

5. Use a tension measuring device to monitor pulling force on each pull of conductors for critical systems where a pulling winch is used. Record and submit the maximum measured pulling tension for each cable pull.

C. Use solid copper conductors for power circuits 10 AWG and smaller except use stranded conductors in flexible conduits.

D. Use stranded conductors for power circuits 8 AWG and larger.

E. Use copper conductors not smaller than 12 AWG for power and lighting branch circuits.

F. Use stranded copper conductors not smaller than 14 AWG for 120V control circuits.

G. Use minimum 10 AWG copper conductors from panelboard to first outlet for 20-ampere, 120-volt branch circuits longer than 75 feet; use larger conductors as indicated on the Drawings.

H. Use minimum 10 AWG copper conductors from panelboard to first outlet for 20-ampere, 277-volt branch circuits longer than 150 feet; use larger conductors as indicated on the Drawings.

I. Do not “through-pull” conductors at boxes, fittings or cabinets where a change of raceway alignment occurs.

J. Install wiring at outlets with at least 6 inches of slack conductor at each outlet.

3.4 TYPE MC CABLE INSTALLATION

A. Install MC cables according to NECA 120, Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC) (ANSI), the NEC, and requirements in this Section.

B. Route MC cables to meet Project conditions.

C. For branch circuits serving multiple outlets use conduit for the “homerun” from the first outlet or junction box to the branch circuit panelboard; use Type MC cables for branch circuit wiring beyond the first outlet or junction box.

D. Use Type MC cables in interior, dry locations that are classified by the International Building Code as “Business Group B” occupancy where they will be concealed above ceilings, in dry-wall partitions, in equipment enclosures, or below raised floors. Type MC cables may be installed exposed in dedicated electrical rooms and mechanical rooms if they will not be exposed to physical damage or deteriorating agents.

E. Install and support Type MC Cables as required in Article 330 of the NEC. Use NRTL listed spring steel MC Cable supports or UV resistant plastic tie wraps to support Type MC cables; do not use wire to support Type MC cables

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3.5 CONNECTOR INSTALLATION

A. Install conductors in terminals, splices, adapters, and connectors in accordance with the manufacturer’s instructions. Have the manufacturer’s installation instructions available at the construction site.

B. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise above the conductor temperature.

C. Do not nick conductors when removing insulation.

D. Do not cut conductor strands to fit into connectors, splices, adapters, or terminals.

E. Make connections using clean connection surfaces. Wire brush conductors immediately before installing lugs, terminals, splices, or adapters.

F. Connect conductors 1/0 AWG and larger using compression terminals at the locations described below where there is adequate wire bending space to accommodate compression terminals. Select compression terminals suitable for the conductor sizes, materials, and termination point configurations. Install compression terminals using the manufacturer’s recommended dies and minimum 12-ton force compression tools.

1. Circuit breakers with frame size greater than 100 amperes that are NRTL listed for with compression terminals. Use compression adapters where the circuit breaker is not listed for compression terminals.
2. Safety switches and fused switches rated more than 100 amperes.
3. Transformers; refer to Section 26 2213, “Low-voltage Distribution Transformers.”
4. Switchgear, switchboards, panelboards, busway, motor control centers, and similar service and distribution equipment.
5. Utilization equipment connections that are NRTL listed for with compression terminals.

G. Install copper conductors, 1/0 AWG and larger, connected using mechanical lugs, in the locations or conditions described below.

1. Connection points not NRTL-listed for either compression terminals or compression adapters.
2. Where there is insufficient wire bending space to accommodate either compression terminals or compression adapters.
3. 100 ampere frame circuit breakers.
4. 30, 60, and 100 ampere safety switches.

H. Terminate power conductors smaller than 1/0 AWG using mechanical lugs.

I. Terminate control conductors using crimp-on terminals or ferrules. Do not place stranded conductors directly under terminal screws. Install terminals or ferrules on conductors using ratchet-type compression tools.

J. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A-486B.

3.6 INSULATING TAPE AND TUBING INSTALLATION

A. Install insulating tape and tubing in accordance with the manufacturer's instructions. Have the manufacturer's installation instructions available at the construction site.

B. Insulate splices and taps of irregular shapes with manufactured insulating covers or insulating tape built up to not less than 150 percent of insulation rating of conductor.

1. Apply varnished cambric tape over connections where re-entry is likely, such as motor lead connections.
2. Use rubber insulating tape in half-lapped layers to develop the basic insulation over splices and taps.
3. Use vinyl plastic tape in half-lapped layers to provide the outer protective covering over splices and taps.

C. Insulate cylinder shaped splices and taps, connector barrels and adapter barrels using heat shrinkable insulating tubing, insulating covers manufactured for the connector, or tape insulation as described above.

3.7 IDENTIFICATION

A. Identify wire and cable under provisions of Section 26 0553, Identification for Electrical Systems.

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

C. Apply color coding tape on conductors at each termination, splice, junction, and pull box.

D. Post conductor color code on each panelboard, switchboard, switchgear assembly, motor control center, dry-type transformer, safety switch, and separate motor controller. Use type-written, adhesive-backed labels

3.8 FIELD QUALITY CONTROL

A. Observe conductors and cables during the installation process.
1. Reject and replace entire reels, rolls, or boxes containing conductors or cables with material or manufacturing defects.
2. Reject and replace cable or conductor segments that have been kinked, dented, or otherwise damaged during handling or installation.

B. After installation of wires and cables and before electrical circuit is energized, show product capability and compliance with requirements and verify by documented inspections and tests.

C. Perform the following inspections:
1. Inspect conductors and cables for:
   a. Freedom from material defect or physical damage,
   b. Correct conductor size, material, and insulation type,

c. Correct color coding and identification.

2. Inspect connections for:
   a. Correct connector size and type according to the Specifications,
   b. The use of the correct compression dies and the correct number of crimps on compression connectors in accordance with the connector manufacturer's instructions.

D. Perform the following tests:
   1. Before connecting conductors to equipment, use a megohm meter in a 1-minute test to verify the insulation integrity of each service conductor, feeder conductor, critical system branch circuit conductor, and critical system control conductor with respect to ground and other conductors in the same raceway.
      a. Use 1000-volts dc to test conductors rated 600 volts.
      b. Conductors with insulation resistances over 50 megohms are acceptable.
      c. Conductors with insulation resistances less than 2 megohms are defective.

   2. After connecting conductors to equipment, test continuity and correct connection of each power circuit conductor and each control circuit conductor.

   3. Measure and record the tightness of not less than 10% of each size and type of mechanical or bolted connection using a calibrated torque wrench or torque screwdriver.
      a. Compare measured torque with torque recommended by the connector manufacturer or UL Standard 486A-486B.
      b. If any connection is found to be less than 90% of the recommended torque, re-torque all bolted connections on the Project.

E. Remove and replace defective, incorrect, or improperly installed conductors and connectors. Re-inspect and re-test replacement conductors and connectors.

F. Submit test and inspection records.

G. Refer to Section 26 0813, Electrical Acceptance Testing for other inspections and tests that are required before conductors may be energized.

END OF SECTION

SECTION 26 0526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Circuit and System Grounding

B. Enclosure and Equipment Grounding System

C. Isolated Ground System

D. Signal Reference Grid

E. Static Electricity Grounding and Bonding

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 3000 Submittal Procedures:
1. Catalog Data: Submit catalog data for grounding conductors, grounding clamps, grounding bushings, grounding plates, grounding bars, chemical ground rods, exothermic weld materials, compression grounding connector materials, static grounding materials, and signal reference grid materials.
2. Shop Drawings: Submit shop drawings for signal reference grid fabrication and installation.
3. Project Record Documents: Submit project record documents to include specified certifications and field test reports of installed grounding systems.

1.3 REGULATORY REQUIREMENTS

A. Comply with the National Electrical Code (NEC) for components and installation .

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

1.4 RECEIVING, STORING AND PROTECTING

A. Receive, store, and protect, and handle products according to NECA 1 Standard Practices for Good Workmanship in Electrical Construction.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01 3000, Submittal Procedures.

2.2 GROUND ELECTRODE CABLE

A. Provide bare stranded, soft temper copper cable that conforms to ASTM B8 Standard Specification for Concentric-Lay Stranded Copper Conductors.

2.3 CHEMICAL GROUND ROD

A. Provide NRTL listed chemical ground rod(s) as shown on the Drawings.

B. Furnish chemical ground rods fabricated from Type K copper tubing approximately 10 feet long, 2 inches in diameter and containing a hygroscopic electrolyte material.

C. Furnish each chemical ground rod with a 24-inch-long 4/0 AWG copper pigtail, a protective cover box, and sufficient ground ground-enhancing backfill material for installation in a 6 inch augered hole.

D. Manufacturers: Lyncole Industries Inc., LEC Inc., Superior Grounding Systems Inc.

2.4 GROUND ELECTRODE BACKFILL MATERIAL

A. Provide ground enhancement backfill material for ground rods and cable type electrodes.

B. Field-mixed backfill material shall consist of approximately 75 percent gypsum (calcium sulfate), 20 percent bentonite clay, and 5 percent sodium sulfate.

C. Commercial backfill material, when at 300% moisture content ((weight of water/weight of material) x 100), shall have a resistivity of approximately 250 ohm-cm at 30% solids density and a pH of 8 to 10.

D. Manufacturers: Lyncole “Lynconite”, LEC Inc. “GAF”, Superior Grounding Systems “Electro-Fill”

2.5 EQUIPMENT GROUNDING CONDUCTORS

A. Provide NRTL-listed THHN/THWN insulated copper wire.

B. Use solid grounding conductors 10 AWG and smaller where not subject to vibration or repeated flexing.

C. Use stranded grounding conductors for 8 AWG and larger.

D. Use stranded grounding conductors where subject to vibration or repeated flexing.

E. Use stranded grounding conductors in flexible conduit at motor connections.

F. Color code grounding conductors as follows:

1. Equipment ground:

a. Conductors 6 AWG and smaller: Green colored insulation.
b. Conductors 4 AWG and larger: Green colored insulation or black colored insulation with 3/4-inch-wide band of water and oil-resistant green plastic adhesive tape.

2. Isolated ground:
   a. Conductors 6 AWG and smaller: Green colored insulation with continuous yellow stripe.
   b. Conductors 4 AWG and larger: Green colored insulation with continuous yellow stripe or black colored insulation with 3/4-inch-wide bands of water and oil-resistant green and yellow plastic adhesive tape.

2.6 GROUND BAR

A. Provide ground bar, 12 inches long or greater length as indicated on the Drawings, fabricated from 1/4-inch-thick, 4-inch-wide copper stock with (1” + 3/4") x 2" bolt hole pattern to accept NEMA standard lugs. Mount ground bar on 2700-volt standoff insulators.

B. Provide 25 ft. 4/0 AWG copper pigtail exothermically welded to the ground bar.

C. Manufacturer: Harger “GBIT”

2.7 PIPE GROUNDING CONNECTORS

A. Provide NRTL-listed copper-alloy connectors for making cable to pipe connections.
B. Manufacturer: O-Z/Gedney “ABG” or “CG”

2.8 CONDUIT GROUNDING BUSHINGS

A. Provide NRTL-listed, galvanized malleable iron, 150 C rated insulated throat grounding bushings with lay-in type ground cable lugs.

B. Manufacturers: O-Z/Gedney Type “BLG”

2.9 EXOTHERMIC WELD GROUNDING CONNECTIONS

A. Provide molds and welding material for making exothermic weld connections.

B. In interior locations and in vaults, use low smoke emission type welding material.

C. Match mold and weld material to material types, shapes and sizes to be joined.

D. Manufacturer: ERICO Cadweld

2.10 COMPRESSION GROUNDING CONNECTIONS

A. Provide wrought copper connectors, terminals, taps, and splices for making irreversible compression grounding connections.

B. Furnish NRTL-listed grounding connectors that are suitable for direct burial and have been tested successfully according to the requirements of IEEE Std. 837 IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

C. Provide connector manufacturer's hydraulic compression tools and dies that match the connectors.

D. Match connector and die size to material shapes and conductor sizes to be joined.

E. Use two-hole heavy-duty compression lugs for bolted connections to ground bars, ground plates, and equipment ground pads.

F. Manufacturer: Burndy "Hyground"

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work of other trades likely to damage grounding and bonding material has been completed.

B. Verify that field measurements are as shown on Drawings.

C. Electrode locations and grounding cable routing shown on Drawings are approximate unless dimensioned.

1. Install electrodes and route cable as required meeting project conditions.
2. Where electrode location or cable routing is not shown, and destination only is indicated, determine exact locations, routing, and lengths required to meet project conditions.

3.2 PREPARATION

A. Examine equipment and building finishes that are to receive grounding and bonding material for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 GENERAL

A. Comply with the requirements of the NEC, this Section and the Drawings.

B. Install grounding and bonding material according to manufacturer's instructions. Have the manufacturer's installation instructions available at the construction site.

C. Use the following connection methods unless otherwise specified or indicated on the Drawings:

1. Use exothermic weld grounding connections for underground or concealed connections of dissimilar materials.
2. Use exothermic weld or compression grounding connections for underground or concealed connections of like materials.
3. Use exothermic weld, compression, or bolted grounding connections for accessible connections.
4. Make bolted connections using bolts, nuts, flat washers, and toothed lock washers suitable for the connector and the installation environment; acceptable materials include high strength silicon bronze and 18-8 alloy stainless steel.
5. Make irreversible bolted connections using 18-8 alloy stainless steel tamper-resistant bolts and tamper-resistant nuts along with flat washers, and toothed lock washers. Tamper-resistant nuts and bolts must resist loosening with common tools; acceptable tamper-resistant fasteners include penta-head, break-away, and oval designs.

D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B. Use a calibrated torque wrench.

E. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Follow connector manufacturer's installation instructions and use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.

F. Install exothermic welds in accordance with manufacturer's instructions and recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

G. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
2. Make connections with clean bare metal at points of contact.
3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.
4. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

H. Comply with requirements in Section 26 0529, Hangers and Supports for Electrical Systems.

3.4 MAIN GROUNDING ELECTRODE SYSTEM

A. Concrete Encased Electrode: Where available, use the building concrete grade beam or strip footing to make a concrete encased main grounding electrode; use either copper ground cable or reinforcing steel as follows:

1. Install a continuous ground cable in the bottom one-third of the grade beam around the entire perimeter of the building. Use ground cable as indicated on the Drawings, not smaller than the grounding electrode cable required by the NEC, and not smaller than 4 AWG. Space cable from the bottom and sides of the grade beam so it has at least 2 inches of concrete coverage.
2. Make one or more reinforcing bars located in the bottom one-third of the footing, electrically continuous around the entire perimeter of the building. Use galvanized or uncoated reinforcing bars not smaller than the following sizes based on the total length of the interconnected and paralleled reinforcing bars:

Total length of reinforcing bars:	Minimum reinforcing bar size:
112 ft.	1-3/8” (#11 bar)
150 ft.	1” (#8 bar)
192 ft.	3/4” (#6 bar)
223 ft.	5/8” (#5 bar)
268 ft.	1/2” (#4 bar)

Bond the reinforcing bars together using bare copper ground cable jumpers that are either exothermically welded to the reinforcing bars or connected using hydraulically compressed tap connectors. Use jumpers compatible with the tap fitting that are not smaller than the grounding electrode cable required by the NEC and not smaller than 4 AWG.

B. Supplemental Electrodes: Install one or more of the following supplemental grounding electrodes to obtain the required ground resistance or to establish a main grounding electrode that is separate from the lightning protection ground.

1. Install one or more chemical ground rods located 5 ft. outside the building perimeter and at least 6 ft. from any lightning protection grounding. Install ground rods in 6-inch diameter augered holes with at least 10 ft. separation between rods. Backfill each hole with a slurry of ground electrode backfill material in accordance with the chemical ground rod manufacturer’s instructions. Install protective cover box, suitable for the traffic at the location, over each electrode.
2. Install a bare copper ground cable not smaller than the grounding electrode cable required by the NEC and not smaller than 2 AWG, not less than 20 ft. long, buried

not less than 30 inches deep adjacent to the building foundation. Encase the electrode in a 2-inch envelope of ground electrode backfill material slurry.

3. Install a bare copper ground cable not smaller than the grounding electrode cable required by the NEC and not smaller than 4 AWG at least 20 ft. long in the concrete envelope for the building electrical service conduits. Position ground cable in concrete to provide not less than 2 inches cover on all sides.

C. Main Ground Electrode Ground Bar:

1. Install a main electrode ground bar in an accessible location in the main electrical room adjacent to the service entrance equipment.
2. Make an irreversible connection between the main electrode ground bar and the main grounding electrode conductor; use exothermic weld connection or compression grounding lug with tamper-resistant fasteners.
3. Main ground electrode ground bar extensions may be established at additional locations by installing ground bars or ground plates connected to the main electrode ground bar using 4/0 AWG insulated ground conductor with an irreversible connection to each ground bar.
4. Connections to the main ground electrode ground bar or extensions will be considered as connections directly to the main ground electrode.

D. Bond exterior underground metal fire protection and potable water service pipes to the main ground electrode bar; use pipe grounding fittings and ground cable as indicated on the Drawings, or not smaller than the grounding electrode cable required by the NEC and not smaller than 4 AWG. Make bond to each water pipe at an accessible location within 5 ft. of where it enters the structure. Comply with NEC requirements for bonding around water meters and insulating joints.

E. Bond the nearest building perimeter structural steel column or effectively grounded metal structure to the main ground electrode ground bar; use ground cable as indicated on the Drawings, or not smaller than the grounding electrode cable required by the NEC and not smaller than 4 AWG.

F. Bond each interior metal piping system to the main ground electrode bar; use pipe grounding fittings and ground cable as indicated on the Drawings, or not smaller than the grounding electrode cable required by the NEC and not smaller than 4 AWG. Make bond to each pipe at an accessible location.

G. Bond each building perimeter structural steel column to the main grounding electrode use ground cable as indicated on the Drawings, or not smaller than the grounding electrode cable required by the NEC and not smaller than 4 AWG.

H. Label each conductor connected to the main ground electrode ground bar or main ground electrode ground bar extensions. Refer to Section 26 0553, Electrical Acceptance Testing.

3.5 CIRCUIT AND SYSTEM GROUNDING

A. Connect the service entrance equipment ground bus to the main electrode ground bar; use ground cable as indicated on the Drawings, or not smaller than the grounding electrode conductor required by the NEC and not smaller than 4 AWG.

B. In the service entrance equipment, connect the neutral bus to the ground bus using a bonding jumper not smaller than the grounding electrode conductor required by the NEC; do not use a bonding screw for this purpose. Make no other neutral-to-ground connections on the load side of the service entrance disconnect.

C. Separately Derived Systems:

1. Connect ground bus of first disconnecting means for separately derived systems (e.g. dry type transformers, power distribution units, generators, and uninterruptible power supplies) in the vicinity of the main electrical equipment room to the main electrode ground bar; use grounding conductor sized as shown on the Drawings or as required by the NEC.
2. Connect ground bus of first disconnecting means for separately derived systems that are remote from the main electrical room to the nearest effectively grounded building structural steel column and the nearest effectively grounded metal water pipe; use grounding conductor sized as shown on the Drawings or as required by the NEC. Make connections at accessible locations.
3. Connect ground bus of first disconnecting means for separately derived systems that are remote from the main electrical room to an extension of the main electrode ground bar if there is neither a nearby effectively grounded building structural steel column nor an effectively grounded metal water pipe; use grounding conductor sized as shown on the Drawings or as required by the NEC.
4. At the first system overcurrent device or disconnecting means, connect the neutral bus to the ground bus using a bonding jumper sized as required by the NEC; do not use a bonding screw for this purpose. Make no other neutral-to-ground connections on the load side of the separately derived system disconnect.

3.6 ENCLOSURE AND EQUIPMENT GROUNDING

A. Provide permanent and effective equipment, enclosure, and raceway grounding in accordance with NEC requirements and as further specified or shown on the Drawings.

B. Provide an equipment ground bar, separate from any neutral bar, in all switchgear, switchboards, panelboards, transformers, motor control centers, starters, disconnect switches, cabinets, etc., for grounding the enclosure and for connecting other equipment and raceway ground conductors. Make connections to the ground bar using mechanical lugs or compression lugs.

C. Make connections and couplings on metallic conduit systems wrench tight.

D. Bonding Bushings:

1. Install bonding bushings on metallic conduit containing circuits rated 100 amperes and higher.
2. Install bonding bushings on metallic conduits entering enclosures through concentric, eccentric or oversize knockouts.
3. Install bonding bushings on metallic conduits that terminate to a metallic enclosure without effective electrical connection such as locknuts or threaded bushings.
4. Bond conduit bonding bushing lug to the equipment ground bar or ground lug in switchgear, panelboards, transformers, motor control centers, starters, disconnect switches, cabinets, etc. Size bonding jumpers in accordance with the NEC.

E. Provide an insulated equipment grounding conductor for each feeder and branch circuit.

1. Install the grounding conductor within the common conduit or raceway with the related phase and neutral conductors and connect to the grounding terminal or grounding bus in each box or cabinet.
2. Size equipment ground conductor in accordance with the NEC or as shown on the Drawings.

F. In each 15 or 20 ampere branch circuit outlet box and junction box, install a green colored washer head grounding screw with a 12 AWG equipment grounding conductor pigtail.

G. Connect receptacle grounding terminals to the equipment ground system using minimum 12 AWG equipment grounding conductor. Do not use a "self-grounding" receptacle strap as the only equipment grounding path.

H. Install an equipment grounding conductor in each cable tray; size conductor per the NEC, but not smaller than 6 AWG. Bond grounding conductor to each cable tray section using UL Listed cable tray ground clamps.

3.7 UNDERGROUND DUCTBANK SYSTEM GROUNDING

A. Refer to Section 33 7119, Electrical Underground Ducts and Manholes.

3.8 FIELD QUALITY CONTROL

A. General: Perform on-site verification, certification and acceptance testing of the grounding installation during construction. Verification and testing will be witnessed by designated City of Grants representatives.

B. Notify the City of Grants ten (10) working days in advance of the expected completion of a grounding system installation. Verification and testing can be scheduled in parts or by area depending on the system and construction schedule.

C. Before work is concealed verify and certify that the following grounding installations have been made correctly:

1. The building grounding electrode system. This includes the bonding of the foundation reinforcing bars, bonding of the structural steel columns, and bonding of other metallic systems and other grounding electrode systems.

2. Ground plates and grounding bars.
3. All other underground grounding installations.

D. Acceptance Testing: Perform acceptance testing and submit written reports in accordance with the requirements of Section 26 0813, Electrical Acceptance Testing.

E. Tests will be witnessed by designed City of Grants representatives.
1. Perform ground-impedance measurements using the "fall-of-potential" method in accordance with IEEE 81 Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System. Use instrumentation specifically designed for ground impedance testing. Provide sufficient spacing of test electrodes so that the plotted curves flatten in the 62% area of the distance between the item under test and the current electrode. When sufficient spacing of electrodes is impractical for the "fall-of-potential" method, perform ground-impedance measurements using either the "intersecting curves method" or the "slope method", referenced in IEEE Std. 81. Investigate and correct ground resistances that exceed the following values:
   a. Service rated 50 kVA or less: as required by the NEC
   b. Service rated more than 50 kVA but less than 2500 kVA: 5 Ohms
   c. Service rated 2500 kVA or greater: 1 Ohm
2. Test equipment ground resistances for the following items. Measure resistance between the equipment item and the Main Ground Electrode Ground Bar. Use the "two-point method" of IEEE Std. 81. Investigate and correct equipment ground resistances that exceed 0.5 ohm.
   a. Transformers
   b. Switchgear and Switchboards
   c. Panelboards
   d. Generators
   e. Motor Control Centers
   f. Motors larger than 1 HP
   g. UPS Systems

F. Test static electricity bonding and grounding system resistances. Measure resistance between the static protection area ground bus and the Main Ground Electrode Ground Bar. Use the "two-point method" of IEEE Std. 81. Investigate and correct equipment ground resistances that exceed 10 ohms.

G. Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe any measures taken to improve test results.

END OF SECTION

SECTION 26 0533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Conduits and fittings

B. Outlet boxes

C. Pull and junction boxes

D. Floor boxes

E. Surface metal raceways

F. Wireway

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 30 00 Submittal Procedure:

1. Catalog Data: Submit catalog data describing floor boxes. Include data substantiating that materials comply with specified requirements.
2. Catalog Data: Submit catalog data describing surface metal raceway. Include data substantiating that materials comply with specified requirements.
3. Catalog Data: Submit catalog data describing wireway. Include data substantiating that materials comply with specified requirements.

1.3 QUALITY ASSURANCE

A. Comply with the *National Electrical Code* (NEC) for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL).

1.4 RECEIVING, STORING, AND PROTECTING

A. Receive, store, and protect, and handle products according to NECA 1 – Standard *Practices for Good Workmanship in Electrical Construction*.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01 2500 – Submittal Procedures.

2.2 COATINGS

A. Provide products with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic that is suitable for the environment in which the product will be installed and used.

2.3 ELECTRICAL METALLIC TUBING AND FITTINGS (EMT)

A. Furnish galvanized electrical metallic tubing (EMT) that conforms to UL797 – *Electrical Metallic Tubing*, NEMA C80.3 – *Steel Electrical Metallic Tubing (EMT)*.

B. Furnish compression- or set-screw-type fittings that meet UL514B – *Fittings for Conduit and Outlet Boxes*, and ANSI/NEMA FB1 – *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*. Furnish insulated-throat connectors.

2.4 INTERMEDIATE METAL CONDUIT AND FITTINGS (IMC)

A. Furnish intermediate metal conduit (IMC), nipples, elbows, and couplings that conform to UL1242 – *Intermediate Metal Conduit*, NEMA C80.6 – *Electrical Intermediate Metal Conduit (EIMC)*.

B. Furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that meet the requirements of UL514B – *Fittings for Conduit and Outlet Boxes*, and ANSI/NEMA FB1 – *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*.

2.5 RIGID METAL CONDUIT AND FITTINGS (RMC)

A. Furnish rigid metal conduit (RMC) that meets the requirements of UL6 – *Rigid Metal Electrical Conduit*, NEMA C80.1 – *Electrical Rigid Steel Conduit (ERSC)*.

B. Furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that meet the requirements of UL514B and ANSI/NEMA FB1.

2.6 RIGID NON-METALLIC CONDUIT AND FITTINGS (RNC)

A. Furnish rigid non-metallic conduit (RNC) that conforms to UL651 – *Schedule 40 and 80 Rigid PVC Conduit*, NEMA TC 2 – *Electrical Plastic Tubing and Conduit*.

B. Furnish non-metallic, solvent-welded socket fittings that meet the requirements of UL514C – *Non-Metallic Fittings for Conduit and Outlet Boxes*, and NEMA TC 3 – *PVC Fittings for Use with Rigid PVC Conduit and Tubing*.

2.7 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Furnish galvanized steel flexible metal conduit that meets the requirements of UL1 – *Flexible Metal Electrical Conduit*.

B. Furnish zinc-plated malleable iron fittings that meet the requirements of UL514B – *Fittings for Conduit and Outlet Boxes*, and ANSI/NEMA FB1 – *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*. Furnish insulated throat connectors.

2.8 LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

A. Furnish liquid-tight flexible metal conduit that meets the requirements of UL360 – *Liquid-Tight Flexible Steel Conduit, Electrical*.

B. Furnish zinc-plated malleable iron or zinc-plated steel liquid-tight fittings that meet the requirements of UL514B – *Fittings for Conduit and Outlet Boxes*, and ANSI/NEMA FB1 – *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*. Furnish insulated-throat connectors.

2.9 INSULATING BUSHINGS

A. Provide NRTL-listed, insulating bushings with 105 ºC rated insulation.

B. Manufacturer: O-Z/Gedney, Type IB.

2.10 GROUNDING BUSHINGS

A. Provide NRTL listed, malleable iron, 150 ºC rated insulated-throat grounding bushings with lay-in type ground cable lugs -- zinc-plated for interior applications, galvanized for exterior applications.

2.11 EXPANSION FITTINGS

A. d expansion fittings with hot dipped galvanized malleable iron body, factory installed packing and a bonding jumper.

B. Manufacturer: O-Z/Gedney, Type AX, TX or EXE with Type BJ bonding jumper.

2.12 RACEWAY SEALS

A. Duct Sealant
   1. Furnish a two-part, foam-based, duct sealing system.
   2. Provide sealing compound specifically listed for use with the foam damming materials.
   3. Manufacturer: Polywater FST-250

B. Sealing Fittings for Use in Hazardous-Classified Locations
   1. Furnish zinc-plated, malleable iron sealing fittings that meet the requirements of UL1203 Explosion-Proof and Dust-Ignition-Poof Electrical Equipment for Use in Hazardous (Classified) Locations.

2. Select each sealing fitting so the cross-sectional area of conductors passing through the seal is not more than 25 percent of the cross-sectional area of a rigid metal conduit of the same trade size unless the fitting is specifically identified for a higher percentage of fill.
3. Provide sealing compound specifically listed for use with the sealing fitting.
4. Manufacturer: Crouse-Hinds Type EYS, EYSX, EYD.

2.13 CORROSION PROTECTION TAPE

A. Furnish pressure-sensitive, 10 mil thick. PVC based tape for corrosion protection of metal conduit and fittings.

B. Manufacturer: 3M, Type 50.

2.14 RACEWAY MEASURING TAPE

A. Furnish raceway measuring tape with permanently printed measurements in one-foot increments and minimum 1200 lb average breaking strength.

B. Manufacturer: Greenlee “39243”.

2.15 SURFACE METAL RACEWAY

A. Furnish surface metal raceway that meets the requirements of UL5 – *Surface Metal Electrical Raceways and Fittings*.

B. Furnish surface metal raceway fabricated from cold rolled galvanized steel with a thickness of not less than 0.040 inches and coated with a baked enamel finish.

C. Furnish fittings required for a complete installation.

D. Manufacturer: Wiremold “500” or “700” series.

2.16 POWER AND COMMUNICATIONS SURFACE METAL RACEWAY

A. Furnish power and communications surface metal raceway that meets the requirements of UL5 – *Surface Metal Electrical Raceways and Fittings*.

B. [Furnish power and communications surface metal raceway fabricated from cold rolled galvanized steel with a thickness of not less than 0.04 inches and coated with a gray baked enamel finish.

C. [Furnish power and communications surface metal raceway fabricated from cold rolled galvanized steel with a thickness of not less than 0.04 inches and coated with a polyester topcoat over an ivory colored base.

D. Raceway shall consist of a metal base and a snap on metal cover.

E. Nominal dimensions of the assembled raceway shall be 4-3/4 inches wide by 1-3/4 inches high.

F. Furnish fittings required for a complete installation to include a full-length partition separating the power wiring from the communications cables

G. Provide a plastic snap-in plate for each 36 inches of the power and communications surface metal raceway. Each snap-in plate shall include one isolated ground duplex receptacle and one connector faceplate for two RJ11/RJ45 telecommunications connectors.

H. Manufacturer: Wiremold “4000” or “6000”.

2.17 WIREWAY

A. Provide NRTL listed, [general purpose] [oil-tight and dust-tight] [rain-tight] type wireway with covers, elbows, tees, and fittings required for a complete system.

B. Supply wireway [with manufacturer's standard] [without] [with bottom only] knockouts.

C. Manufacturer: Square D “Square-Duct”.

2.18 OUTLET BOXES

A. Provide outlet boxes selected for specific installations using the guidance in NEMA OS 3, *Selection and Installation Guidelines for Electrical Outlet Boxes*, and the requirements of this Section.

B. For dry locations provide galvanized steel outlet boxes that comply with UL Standard 514-A – *Metallic Outlet Boxes* and ANSI/NEMA OS1 – *Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports*.

1. For luminaire outlets use 4-inch x 1-1/2-inch-deep octagonal boxes with fixture stud attachment as required to support luminaires.
2. For fire detection and alarm device outlets use boxes specified in Section 28 3100.
3. For flush outlets in stud walls or above-grade cast-in-place concrete walls use 4-inch square x 1-1/2-inch-deep boxes; provide deeper boxes or multiple gang boxes as required to fit devices. Provide raised device covers that match the thickness of the wallboard and the number of devices. Provide supplemental box supports to prevent movement of the box.
4. For flush outlets in above-grade masonry walls use masonry boxes with conduit knockouts. Provide boxes with depth suitable for the masonry unit size. Provide multiple gang boxes as required by the number of devices.
5. For surface outlet boxes in EMT raceway systems, use 4-inch x 2-1/8-inch-deep square boxes. Provide deeper boxes or multiple gang boxes as required to fit devices. Provide square surface covers that match the installed device and have not less than two holes for securing the device to the cover.

C. For damp or wet locations and for surface-mounted RMC or IMC raceway systems, provide outlet boxes that comply with UL Standard 498 and 514, ANSI/NEMA FB1.

1. For lighting fixture outlets use 4-inch x 2-1/16-inch-deep round cast gray or malleable iron boxes with threaded hubs.
2. For flush or surface wall-mounted outlets, use 4-11/16 square, 2-11/16-inch-deep cast gray or malleable iron boxes with threaded hubs. Provide multiple gang boxes as required to fit devices. Provide gasketed cast gray or malleable iron or cast copper-free aluminum covers that match the installed device and have not less than two holes for securing the device to the cover.

2.19 RECESSED FLOOR BOXES

A. Provide cast-iron recessed floor boxes with threaded conduit entrances for use in floor slabs on grade or below grade. Floor boxes in suspended floor slabs may be the formed steel type.

B. Provide fully adjustable floor boxes as follows:
1. External means to adjust the height of the box before concrete is placed
2. Internal means to adjust the cover to be flush and level with the finished floor after the flooring material is placed.

C. Provide floor boxes with brass covers as required for the system or device to be installed in the box.

D. Provide carpet flanges or covers with integral carpet flanges for floor boxes in carpeted areas.

E. Manufacturer: Hubbell

2.20 MULTI-SERVICE RECESSED FLOOR BOXES

A. Provide fully adjustable cast-iron multi-service recessed floor boxes for use in floor slabs on grade or below grade. Multi-service floor boxes in suspended floor slabs may be the formed steel type.

B. Provide multi-chamber floor boxes with provisions for routing wires between chambers.

C. Provide service plates as required for the systems or devices to be installed in the floor box.

D. Provide flush covers with integral carpet flange and cable doors.

E. Manufacturer: Hubbell

2.21 PULL AND JUNCTION BOXES

A. For dry locations in clean, non-contamination environments use galvanized sheet steel pull and junction boxes that comply with UL Standard 50 Type 1 and the NEC as to size and construction. Use boxes not less than 4 inches square x 1-1/2 inches deep with screw-secured covers. Provide larger boxes as required by the number and size of conduits and conductors.

B. For dry locations in dusty or possible contamination (e.g. beryllium, explosives, or uranium) environments use galvanized steel pull and junction boxes that comply with UL Standard 50 Type 12 and the NEC as to size and construction. Use boxes not less than 6 inches square x 4 inches deep with gasketed covers. Provide larger boxes as required by the number and size of conduits and conductors.

C. For damp or wet, non-corrosive locations, in conduit runs up to 3/4 inch trade size, provide 4-11/16 inches square, 2-11/16 inches deep cast gray or malleable iron pull and junction boxes with threaded hubs and gasketed cast gray or malleable iron or cast copper-free aluminum covers.

D. For damp or wet, non-corrosive locations, in conduit runs 1 inch trade size and larger, provide galvanized sheet-steel pull and junction boxes and covers that comply with UL 50 Type 3R.

E. For damp or wet, non-corrosive locations that are subject to hose-directed water, provide pull and junction boxes and covers that comply with UL 50 Type 4.

F. For damp or wet, corrosive locations provide pull and junction boxes and covers that comply with UL 50 Type 4X.

G. For locations subject to occasional submersion, provide pull and junction boxes and covers that comply with UL 50 Type 6.

H. For in-ground flush-mounted cast metal boxes, provide UL 50 Type 6 boxes with flanged, recessed cover.

1. Material: Galvanized cast iron or galvanized gray or malleable iron.
2. Cover: Non-skid cover with neoprene gasket and stainless-steel screws.
3. Identification: Permanent mark or logo on cover prominently identifying the function of the enclosure in accordance with NEC requirements.

I. For in-ground, non-metallic, open-bottom handholes use products that are NRTL-listed to ANSI/SCTE 77 – *Specification for Underground Enclosure Integrity*.

1. Material: Polymer concrete.
2. Minimum ANSI/SCTE 77 load rating:
   a. Located in sidewalks: Tier 8.
   b. Located in driveways, parking lots, and off-roadway locations: Tier 15.
3. Size: Up to 30” x 48”
4. Cover: Non-skid cover with stainless steel cover bolts.
5. Identification: Permanent mark or logo on cover prominently identifying the function of the enclosure in accordance with NEC requirements.

6. Manufacturer: Quazite “Style PC, PG, or PT”

J. Provide connection points for equipment grounding conductors in each box.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 GENERAL

A. Install complete systems of raceways and boxes for wiring systems.

B. Install raceways and boxes according to NECA 1 – *Standard Practices for Good Workmanship in Electrical Construction*, NECA 101 – *Standard for Installing Steel Conduits (Rigid, IMC, EMT)*, NECA 111 – *Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)*, the NEC, the manufacturer’s instructions, and requirements in this Section.

C. Raceway termination points and box locations shown on the Drawings are in approximate locations unless dimensioned. Verify locations before rough-in.

D. Raceway routing is shown on the Drawings in approximate locations unless dimensioned. Coordinate routing with structure and with work of other trades. Route as required for a complete wiring system.

E. Ground and bond raceways and boxes as required in Section 26 05 26 – *Grounding and Bonding for Electrical Systems*.

F. Support raceways and boxes in accordance with the requirements the National Electrical Code, Section 26 0529 – *Hangers and Supports for Electrical Systems*, and Section 26 0548 – *Vibration and Seismic Controls for Electrical Systems*.

G. Identify raceways and boxes as required in Section 26 05 53 – *Identification for Electrical Systems*.

H. Arrange raceway and boxes to maintain headroom and present neat appearance.

I. Install knockout closures in unused openings in boxes or raceways.

3.3 CONDUIT INSTALLATION

A. For low-voltage wiring systems (less than 1000 volts) use conduit materials according to the NEC and the following:

1. Outdoors - underground:

a. Direct buried: Use RNC, tape-wrapped RMC, or tape-wrapped IMC. Do not use RNC where subject to physical damage. Install with 24 inches minimum cover from top of conduit to finished grade or top of paving.
b. Concrete encased: Use RNC, RMC, or IMC for concrete encased underground work. Install with 24 inches minimum cover from top of encasement to finished grade or paving.
c. Grade ducts to drain a minimum of 4 inches per 100 ft to manholes, hand-holes, or drainage point.
d. Align and support ducts to prevent trapping moisture at any point.

2. Outdoors - exposed: Use RMC or IMC.

3. Outdoor corrosive locations (including cooling towers): Use corrosive-resistant conduit and fittings.

4. Outdoors - concealed: Use RMC or IMC for concealed outdoor work. Do not use bare RMC or IMC in direct contact with earth. EMT may be used for concealed outdoor work where not in contact with earth, not encased in concrete, and where not exposed to deteriorating agents.

5. Indoors – exposed outside of designated electrical rooms or telecommunications rooms:

   a. Exposed to severe physical damage during or after installation: Use RMC or IMC.
   b. Exposed to moisture: Use RMC or IMC.
   c. Exposed to corrosives: Use corrosive resistant conduit and fittings.
   d. Not exposed to deteriorating agents and not subject to severe physical damage during or after installation: Use RMC, IMC, or EMT.

6. Indoors – concealed:

   a. Within drywall partitions and above false ceilings: Use RMC, IMC, or EMT.
   b. Within masonry or cast-in-place concrete walls or floors: Use RMC or IMC.
   c. Direct-buried under building floor slabs on grade: Use RNC, tape-wrapped RMC, or tape-wrapped IMC. Locate top of conduits not less than 12 inches below the bottom of the concrete slab. Install warning tape approximately 6 inches above the conduits; install multiple warning tapes above parallel conduit runs wider than 18 inches.
   d. Concrete encased under building floor slabs on grade: Use RNC, RMC, or IMC. Locate top of concrete encasement not less than 12 inches below the bottom of the concrete slab. Install warning tape approximately 6 inches above the concrete encasement; install multiple warning tapes above concrete encasements wider than 24 inches.

7. Install flexible conduit sections where raceways cross expansion joints or seismic joints, where they are attached to parts of the structure with a potential for differential seismic displacement, and where they connect to equipment with designed anchors (seismic controls) or vibration isolators. Refer to Section 26 0529 – *Hangers and Supports for Electrical Systems* and Section 26 0548 – *Vibration and Seismic Controls for Electrical Systems*.

a. For raceway systems from 1/2 through 1-1/4 inches, install a minimum of 2 feet of flexible conduit, maximum length as determined by the NEC.
b. For raceway systems from 1-1/2 through 2 inches, install a minimum of 3 feet of flexible conduit, maximum length as determined by the NEC.
c. For raceway systems larger than 2 inches, install a minimum of 4 feet of flexible conduit, maximum length as determined by the NEC.
d. Arrange the flexible conduit sections to accommodate 4 inches of movement in all directions,
e. Use liquidtight flexible metal conduit outdoors, in wet, damp, or corrosive indoor locations, and in mechanical rooms. Use flexible metal conduit in dry indoor locations.
f. Install pull boxes as required to comply with the limits on conduit bends and distance between pull points in the CONDUIT INSTALLATION article of this Section; count each flexible conduit section described in this article as not less than a 90-degree bend.

8. Connection to vibrating equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment) - Use a minimum of 24 inches; maximum length as determined by the NEC:

a. Outdoors: Use liquidtight flexible metal conduit.
b. In mechanical rooms: Use liquidtight flexible metal conduit.
c. Wet, damp, or corrosive indoor locations: Use liquidtight flexible metal conduit.
d. Dry indoor locations: Use flexible metal conduit.

9. Connections to luminaires: Use 3/8-inch flexible metal conduit or metal-clad cable in 6-foot maximum lengths for tap conductors to luminaires above suspended ceilings.

B. For medium-voltage wiring systems (1 kV or greater but less than 100 kV) use conduit materials according to the NEC and the following:
1. Underground, both outside and inside the perimeter of the building, red concrete encased: Use RNC, RMC, or IMC for concrete encased underground work. Install with 24-inches-minimum cover from top of encasement to finished grade, paving, or building slab.
2. Indoors or outdoors, concealed or exposed: Use RMC or IMC.

C. Use 3/4-inch or larger conduit to enclose multiple conductors larger than 12 AWG.

D. Conceal conduits, unless otherwise indicated on the Drawings, with finished walls, floors and ceilings. Unless otherwise indicated on the Drawings, install concealed conduits with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions.

E. Position parallel underground conduits with not less than 7-1/2 inches center-to-center separation.

F. Install expansion fittings where embedded conduits cross building expansion joints.

G. Use sealing locknuts, hubs, or similar water-resistant fittings on conduits entering the top of switchgear, switchboards, motor control centers, panelboards, cabinets, pull boxes, and similar enclosures that are in damp and/or wet locations.

H. Install insulating bushings or connectors with an insulated throat to protect conductors or cables at conduit terminations.

I. Install conduits as shown on the Drawings or with the following limits of bends and distance between pull points:
   1. Less than 50 ft, follow the NEC.
   2. 50 ft to 100 ft, a maximum of 3 equivalent 90-degree bends.
   3. 100 ft to 150 ft, a maximum of 2 equivalent 90-degree bends.
   4. 150 ft to 200 ft, a maximum of with 1 equivalent 90-degree bend.
   5. Over 200 ft, a straight run with no bend.

J. Stub-Up Connections:
   1. Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor or equipment pad.
   2. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor.
   3. Where equipment connections are not made under this Subcontract, install threaded insert plugs set flush with the floor.

K. Raceway Sealants:
   1. Seal all raceways to prevent the migration of air and water through the interior of the raceway where:
      a. Raceways pass from exterior locations to interior locations.
      b. Raceways pass from warm locations to cold locations, such as the boundaries of refrigerated and air-conditioned spaces.
      c. Raceways enter or leave radiological "controlled areas.”
      d. Raceways go between areas where air pressure differential must be maintained.
      e. Raceways enter an enclosure protected by a clean-agent, total-flooding fire suppression system.
      f. Otherwise required by the NEC.
   2. Locate conduit fittings or boxes at suitable, approved, accessible locations to provide access to the interior of the conduit to be filled with duct sealant.
   3. Install sealant in accordance with the manufacturer’s written instructions.

L. Sealing Fittings
   1. Install conduit sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with NRTL-listed conduit sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
   2. Where conduits enter or leave NEC Class I hazardous locations.

3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
4. Where conduits enter or leave radiological "controlled areas."
5. Where conduits go between areas where air pressure differential must be maintained.
6. Where conduits enter an enclosure protected by a clean agent total flooding fire suppression system.
7. Where otherwise required by the NEC.

M. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduits dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

N. Install plastic-coated RMC and fittings according to the NEC and manufacturer's instructions. Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

O. Do not use RNC 90 degree elbows larger than 2 inch trade size; use plastic-coated RMC, tape-wrapped RMC, or tape-wrapped IMC for 2-1/2 inch trade size and larger 90 degree elbows.

P. Maintain the following minimum clearances between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C):
1. 6 inches at perpendicular crossings.
2. 12 inches between parallel runs.

Q. Avoid moisture traps in conduit system; provide junction boxes with drain fitting at low points in conduit system.

R. Install corrosion protection tape on metal conduits and fittings in contact with soil using half-lapped wrappings.

S. Install grounding bushings at the following locations:
1. At every entry to enclosures on metallic conduits containing circuits rated 100 amperes and higher.
2. On metallic conduits entering enclosures through concentric, eccentric or oversize knockouts.
3. On metallic conduits that terminate to a metallic enclosure without effective electrical connection such as locknuts or threaded bushings.

T. Install conduit measuring tape in empty raceways. Leave not less than 12 inches of slack at each end of the tape. Secure each end of tape.

3.4 CONCRETE ENCASEMENT

A. Concrete-encase underground low-voltage (less than 1000 volts) electrical service and feeder conduits outside the perimeter of the building foundation.

B. Concrete-encase underground medium-voltage (1 kV or greater but less than 100 kV) electrical service and feeder conduits outside and inside the perimeter of the building foundation. Use red-colored concrete.

C. Concrete-encase underground electrical branch circuit, communications, and alarm conduits as indicated on the Drawings.

D. Provide not less than 3 inches of concrete coverage on all sides of conduits.

E. Refer to Section 03 30 00 –*Cast-in-Place Concrete* for basic material and installation requirements. Neither concrete finishing is required for this application.
1. Use a pre-approved concrete mix design that is suitable for exterior use exposed to freezing and thawing.
2. Use un-colored concrete to encase conduits for low-voltage wiring systems
3. Use red-colored concrete to encase conduits for medium voltage cables.
   a. Use 2.0 lb. of pigment per 94 lb. sack of cement.
   b. Manufacturer: Rockwood Industries/Davis Colors, No. 1117.

3.5 FIRE-STOPPING

A. Install an NRTL approved fire-stop system at each electrical penetration in a fire-rated wall, floor, or partition.

3.6 OUTLET BOX INSTALLATION

A. Install outlet boxes with centers at the following heights unless noted otherwise on the Drawings:
1. Receptacle, telephone and data outlets:
   a. Common Areas (such as conference and break rooms): 18 inches above finished floor.
   b. Offices and Workstations: 7 inches above finished floor.
2. Light switches: center 48 inches above finished floor and within 6 inches of door frame.
3. Thermostats: center 48 inches above finished floor.
4. Wall mounted emergency lights: 80 inches above finished floor or 12 inches below the ceiling; whichever is lower.

B. Coordinate outlet box locations with modular furniture and associated hangers.

C. Where the Drawings show outlets as adjacent, align outlet boxes with each other and group them symmetrically.

D. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726, Wiring Devices.

E. Install a multi-gang box where more than one device is mounted together. Do not use sectional type boxes.

F. Install box with plaster ring for single or multiple device outlets.

G. Use flush mounted outlet boxes in finished areas.

1. Install flush outlet boxes and fittings in walls and ceilings so that front edge is flush with the finished surface. Repair broken wall or ceiling surfaces so no gaps or open spaces exceed 1/8 inch at the edge of boxes or fittings.
2. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
3. Do not install flush mounting boxes back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
4. Secure flush mounting boxes to interior wall and partition studs. Accurately position to allow for surface finish thickness.
5. Install stamped steel bridges to fasten multiple flush mounting outlet boxes between studs.
6. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

H. Install adjustable steel channel fasteners for hung ceiling outlet box.

I. Do not fasten boxes to ceiling support wires or other piping systems.

J. Support boxes independently of conduit.

K. Install partitions in boxes as follows:

1. Between 277-volt devices
2. Between 277-volt light switches devices and 120-volt devices.
3. Between either 120 volt or 277 volt devices and low voltage control switches.

L. Install a blank cover plate on each outlet box in which no device is installed.

3.7 FLOOR BOX INSTALLATION

A. Install floor boxes at locations indicated on the Drawings
:

B. Set height of boxes before concrete is placed so cover will be flush with the finished floor surface.

1. Determine the type and thickness of flooring materials and set height of boxes accordingly.
2. In setting box heights, take into account structural deflection that will occur when concrete is placed.

C. Install devices, covers, and carpet flanges after flooring materials are installed; adjust boxes so covers are level and flush with flooring material.

3.8 PULL AND JUNCTION BOX INSTALLATION

A. Install pull and junction boxes as shown on the Drawings and as required for splices, taps, wire pulling, and compliance with regulatory requirements.

B. Install pull boxes as required to comply with limits on conduit bends and distance between pull points in the CONDUIT INSTALLATION article of this Section.

C. Install indoor pull and junction boxes in accessible locations above accessible ceilings and in unfinished spaces. Position boxes so covers can be removed. Place boxes to maintain headroom

.

D. Install a concrete collar around handholes not placed in sidewalks or pavement.

3.9 WIREWAY INSTALLATION

A. Install wireways at locations indicated on the Drawings.

B. Mount plumb and level.

3.10 SURFACE METAL RACEWAY INSTALLATION

A. Install surface metal raceway at locations indicated on the Drawings.

B. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces

C. Mount plumb and level.

3.11 ADJUSTING

A. Adjust flush-mounted outlets to make front flush with finished floor, wall, or ceiling material.

B. Install knockout closures in unused openings in boxes.

3.12 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

3.13 FIELD QUALITY CONTROL

A. Provide final protection and maintain conditions to ensure that coatings and finishes are without damage or deterioration at final inspection.

B. Inspection Points – Provide not less than 2 working days advance notice to the City of Grants for the following LANS inspection points. In the notice identify the particular

areas of the Project for which LANS inspection is requested. Correct deficiencies identified during inspections. If the requested LANS inspection does not occur within 1 working day of the LANS inspection point, work may proceed.

1. Underground conduits: After conduits have been installed but before concrete-encasement or trench backfilling commences. LANS inspection may include but is not limited to:
   a. Correct conduit material and size,
   b. Proper conduit spacing and supports,
   c. Correct conduit stub-up locations.
   d. Conduit connection and coupling integrity
2. Raceway systems in concrete walls, floors, slabs, and equipment pads: After raceways and boxes have been installed but before concrete placement commences. LANS inspection may include but is not limited to:
   a. Correct raceway system materials and sizes,
   b. Proper conduit spacing and supports,
   c. Raceway system connection integrity,
   d. Correct conduit stub-up locations.
   e. Correct floor box locations and proper height setting,
   f. Correct outlet box locations.
3. Raceway systems in drywall partitions: After raceways and boxes have been installed but before drywall installation that would cover the raceway system commences. LANS inspection may include but is not limited to:
   a. Correct raceway system materials and sizes,
   b. Proper supports for raceways and boxes,
   c. Raceway system connection integrity,
   d. Correct outlet box locations and proper depth setting.
4. Raceway systems above ceilings: After raceways and boxes have been installed but before ceiling system installation commences. LANS inspection may include but is not limited to:
   a. Correct raceway system materials and sizes,
   b. Proper supports for raceways and boxes,
   c. Raceway system connection integrity,
   d. Correct outlet box locations and proper depth setting.
5. Fire-stop installation: After fire-stop system has been installed but before covering the installation (with gypsum board etc) commences. LANS inspection may include but is not limited to:
   a. Proper selection and installation of fire stop system.

END OF SECTION

SECTION 26 0553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Component identification tags.

B. Equipment nameplates.

C. Outlet labels.

D. Wire markers.

E. Voltage markers.

F. Warning signs.

G. Arc flash and shock hazard warning labels.

H. Working space markers.

I. Underground warning tape.

J. One-line diagrams and operating instructions.

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 3000 Submittal Procedures:
1. Catalog Data: Submit manufacturer’s catalog literature for each product.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
3. Manufacturer's Installation Instructions: Submit installation instructions, indicating special procedures and installation requirements.

1.3 REGULATORY REQUIREMENTS

A. Conform to requirements of the National Electrical Code (NEC), NFPA 70E, and OSHA.

B. Conform to applicable requirements of the following ANSI Standards:

1. Z535.1 Safety Color Code.
2. Z535.2 Environmental and Facility Safety Signs.
3. Z535.3 Criteria for Safety Symbols and Labels.
4. Z535.4 Product Safety Signs and Labels.
5. Z535.5 Safety Tags and Barricade Tapes (for Temporary Hazards).

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Subcontract Documents, Shop Drawings, and manufacturer's wiring diagrams, with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01 3000, Submittal Procedures.

2.2 COMPONENT IDENTIFICATION TAGS

A. Furnish component identification tags as specified below and scheduled on the Drawings to identify electrical equipment using the system designation, equipment identification, tech area number, and building number.

B. Coordinate electrical component identification tag schedule with final equipment identification scheme for project.

C. Provide component identification tags with black letters on yellow background with 2 inches by 3 inches dimensions.

D. Provide minimum 48-point size lettering.

E. Provide tags made of one of the following materials:

1. Type 1 (Indoor Applications Only):
   a. Laminated plastic adhesive tape with machine printed letters.
   b. Manufacturer: Brother, Seton, Brady.
2. Type 2:
   a. Two-ply plastic nameplate with letters engraved through yellow surface showing black core.
   b. Provide UV stabilized material for outdoor applications.
   c. Manufacturer: Seton Nameplate Corp.

2.3 EQUIPMENT NAMEPLATES

A. Furnish equipment nameplates as specified below and scheduled on the Drawings to indicate the following information:

1. Category I nameplates:
   a. Served by nameplates: circuit directory information including circuit number, equipment identification, and location of equipment serving the item, plus the voltage, number of phases, and number of wires.
   b. Serves nameplates: circuit directory information including circuit number, equipment identification, and location of equipment served, plus the voltage, number of phases, and number of wires.

2. Category II nameplates – general or operational information including basic instructions or specific operating procedures.
3. Category III nameplates – emergency operations information including emergency shutdown procedures.

B. Coordinate equipment nameplate schedule with equipment numbering scheme provided by Subcontract Technical Representative.

C. Provide nameplates made of one of the following materials:
1. Type 2:
   a. Two-ply plates with letters engraved through surface color showing core color.
   b. Use UV stabilized material for outdoor applications.
   c. Manufacturer: Seton Nameplate Corp.

D. Provide 10-point minimum size lettering.

E. Provide colors as follows:
1. Category I nameplates: white or black letters on blue background.
2. Category II nameplates: white letters on black background.
3. Category III nameplates: white or black letters on red background.

F. Dimensions shall be as follows:
1. Category I nameplates: 1 inch by 2 1/2 inch minimum.
2. Category II nameplates: as required for instructions, 1 inch by 2 1/2 inch minimum. Category III nameplates: as required for instructions, 1 inch by 2 1/2 inch minimum.

2.4 OUTLET LABELS

A. Furnish a typewritten or machine printed label for each switch and receptacle outlet indicating circuit number, panelboard, and voltage.

B. Provide labels of the following materials:
1. Laminated plastic adhesive tape with machine printed letters.
2. Manufacturer: Brother, Seton, Brady.
3. Provide black, 10-point minimum size lettering on a white background.

2.5 WIRE MARKERS

A. Provide wire markers for power, control, instrumentation, alarm, and communication circuit wires.

B. Furnish split sleeve, heat-shrinkable sleeve, or self-laminating adhesive wire markers.

C. Locate a wire marker on each conductor at switchgear, panelboards, pull boxes, outlet and junction boxes, and each load connection.

D. Provide typewritten lettering on wire markers as follows:

1. Power and lighting circuits: as-built branch circuit or feeder circuit number.
2. Control circuits: as-built control wire number indicated on schematic and interconnection diagrams or equipment manufacturer's wiring diagrams.

E. Manufacturer: LEM Products, Inc., Brady, Panduit.

2.6 VOLTAGE MARKERS

A. Furnish voltage markers for transformers, switchgear, panelboards, starters, motor control centers, safety switches, pull boxes, cabinets, and conduits.

B. Provide flexible pressure sensitive vinyl markers with minimum 1-inch X 4 inches orange background and black letters.

C. Provide voltage markers with lettering indicating the highest voltage present:

1. 480Y/277 and 480-volt system: 480 VOLTS

D. Manufacturer: Electromark, LEM Products, Inc.

2.7 WIRING SYSTEM COLOR CODE LABELS

A. In buildings with more than one voltage system, provide wiring system color code labels on each panelboard, switchboard, switchgear, and motor control center.

B. Provide labels with black, 10-point minimum size lettering on a white background.

C. Provide labels of the following materials:

1. Outdoor labels shall be suitable for a high-UV environment.
2. Provide machine-produced custom labels printed using a thermal transfer process:
   a. Use polyester label stock that is NRTL-recognized to UL969, Marking and Labeling Systems, and has a high adhesion adhesive back.
   b. Use printing ribbon recommended by the label stock manufacturer.
3. Use a suitable label-printing machine to generate labels.
4. Manufacturer: Brother, Seton, Brady.

2.8 WARNING SIGNS

A. Furnish warning signs for low-voltage and medium-voltage transformers, switchgear, switchboards, panelboards, motor starters, motor control centers, safety switches, pull boxes, and cabinets.

B. Use warning signs that conform to ANSI Z535.4 and OSHA Danger and Caution specifications.

C. Provide minimum 2 inches X 4 inches warning signs.

D. Provide warning signs with format and lettering as follows:

1. Signal word: DANGER
2. Signal word panel color: red with safety alert symbol.
3. Word message:
   Keep Out!

Hazardous voltage inside
Will shock, burn, or cause death.

4. Safety symbol: ISO 3864 “lightning bolt” in yellow triangle.

E. Materials:

1. For indoor applications use flexible, pressure sensitive, polyester base with polyester over-laminate.
2. For outdoor applications use aluminum signs.

Manufacturer: Seton Name Plate Co., Safety Label Solutions, Hazard Communication Systems, Electromark.

2.9 ARC FLASH AND SHOCK HAZARD WARNING LABELS

A. Furnish arc flash and shock hazard warning labels for switchgear, transformers, panelboards, industrial control panels, motor controllers (including those furnished with mechanical equipment), motor control centers, safety switches, and other equipment as required by the NEC or NFPA 70E.

B. Provide warning labels that comply with ANSI Z535.4. Color in top part of WARNING sign shall be ANSI “safety orange.” Color in top part of DANGER sign shall be red. All lettering on labels shall be black.

C. Provide either machine-produced custom labels or manually filled-in pre-printed labels similar in design to those below.

1. Label dimensions shall be approximately 4 inches high by 5 inches wide.
2. Outdoor labels shall be suitable for a high-UV environment.
3. Machine-produced custom labels:
   a. Use polyester label stock that is NRTL-recognized to UL969, Marking and Labeling Systems, and has a high adhesion adhesive back.
   b. Use printing ribbon recommended by the label stock manufacturer.
   c. Use a suitable thermal transfer process label-printing machine to generate labels and enter the application-specific information indicated in the installation sub-paragraphs.
4. Pre-printed labels:
   a. Use labels printed on self-adhesive UV-resistant polyester with pressure-sensitive adhesive back. Provide labels with a clear polyester overlay film to protect manually-entered information.
   b. Use a black, UV-resistant, industrial permanent marker pen to legibly hand letter the application-specific information indicated in the installation sub-paragraphs.

D. Use the following warning label design for equipment operating at 240 volts and above, and for equipment operating below 240 volts that is served by one or more transformers with an aggregate rating of 125 kVA or larger. See installation sub-paragraphs for an explanation of the application-specific information entries on the label.

WARNING	
Arc Flash and Shock Hazard. Appropriate PPE Required.	
## inches	Arc-Flash Protection Boundary (from exposed live parts).
##.# cal/sq cm	Arc Flash incident energy at ## inches working distance; use approved PPE with Arc Thermal Performance Value ≥ incident energy; use additional PPE on body parts that may be closer.
#	NFPA 70E Hazard/Risk Category for operations with doors closed
### Vac	Shock Hazard exists when door is open or cover is off _____ .
## inches	Limited Approach Boundary
## inches	Restricted Approach Boundary } Class ## Gloves,
# inch	Prohibited Approach Boundary } #### V-Rated Tools
Equipment I.D.: ######-##-####-#	Date: MM/DD/YYYY .
Served From: ####-# Location: ## ###	Ckt: ## Volts/Ph/W: ###/#/# .
Serves: ####-# Location: ## ###	Ckt: ## Volts/Ph/W: ###/#/# .

E. Use either the above warning label design or the following warning label design for equipment operating below 240 volts and served by one or more transformers with an aggregate rating smaller than 125 kVA. See installation sub-paragraphs for an explanation of the information entries on the label.

WARNING
Shock Hazard. Appropriate PPE Required.

0	NFPA 70E Hazard/Risk Category	
208 Vac	Shock Hazard exists when cover is off _____.	
42 inches	Limited Approach Boundary	
Avoid Contact	Restricted Approach Boundary	Class 00 Gloves,
Avoid Contact	Prohibited Approach Boundary	1000 V-Rated Tools

Equipment I.D.: ######-##-####-# Date: MM/DD/YYYY .
Served From: ####-# Location: ## ### Ckt: ## Volts/Ph/W: ###/#/# .
Serves: ####-# Location: ## ### Ckt: ## Volts/Ph/W: ###/#/# .

F. Use the following danger label design for equipment operating at 240 volts and above where the calculated arc-flash incident energy is 40 cal/cm^2 or greater. See installation sub-paragraphs for an explanation of the application-specific information entries on the label.

DANGER
Arc Flash and Shock Hazard. Appropriate PPE Required.

## inches	Arc-Flash Hazard Boundary (from exposed live parts)
##.# cal/sq cm	Arc Flash incident energy at ## inches working distance; use approved PPE with Arc Thermal Performance Value ≥ incident energy; use additional PPE on body parts that may be closer.
#	NFPA 70E Hazard/Risk Category Number for operations with doors/covers closed and latched/bolted.
### Vac	Shock Hazard when door is open or cover is off _____ .
## inches	Limited Approach Boundary
## inches	Restricted Approach Boundary } Class ## Gloves,
# inch	Prohibited Approach Boundary } #### V-Rated Tools

Equipment I.D.: ######-##-####-# Date: MM/DD/YYYY .
Served From: ####-# Location: ## ### Ckt: ## Volts/Ph/W: ###/#/# .
Serves: ####-# Location: ## ### Ckt: ## Volts/Ph/W: ###/#/# .

G. Manufacturer: Summit Electric Supply, Seton Name Plate Co., Safety Label Solutions, Hazard Communication Systems, Electromark, Brady.

2.10 WORKING SPACE FLOOR MARKING

A. Provide black paint and white paint to mark the NEC-required working space on the floor at electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized.

B. Refer to Section 09 9100 Painting.

2.11 WORKING SPACE LABELS

A. Provide labels indicating required working clearance at electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized and it is impractical mark the NEC-required working space on the floor

B. Material:

1. Use polyester label stock that is NRTL-recognized to UL969, Marking and Labeling Systems, and has a high adhesion adhesive back.

2. Use printing ribbon recommended by the label stock manufacturer.
3. Use a suitable thermal transfer process label-printing machine to generate labels and enter the application-specific information
4. Outdoor labels shall be suitable for a high-UV environment.

C. Minimum dimensions: 3-1/2 x 1-1/4 inches.

D. Use the following label design:

NOTICE
Keep area in front of this electrical equipment clear for #-#/# feet. OSHA-NEC regulations.

1. Signal word: “NOTICE” in 24-point minimum white italic letters on safety blue panel.
2. Word message: 16 point minimum black or safety blue letters on white background.
   a. Word message for 120/240-volt and 208Y/120-voltequipment: ”Keep area in front of this electrical equipment clear for 3 feet. OSHA-NEC regulations.”
   b. Word message for 480-volt and 480Y/277-volt equipment with exposed live parts on one side of the working space and no live parts on the other side of the working space: “Keep area in front of this electrical equipment clear for 3-1/2 feet. OSHA-NEC regulations.”
   c. Word message for 480-volt and 480Y/277-volt equipment with exposed live parts on both sides of the working space: “Keep area in front of this electrical equipment clear for 4 feet. OSHA-NEC regulations.”

E. Manufacturer: Brother, Seton, Brady

2.12 UNDERGROUND WARNING TAPE

A. Furnish underground warning tape for underground cables, conduits and duct banks.

B. Use 6-inch wide, 0.004 inch thick, polyethylene underground warning tape black lettering and the following background colors:

1. Electric: red
2. Telephone/data: orange

C. Provide lettering that indicates the type service buried below.

1. Electric: "CAUTION ELECTRIC LINE BURIED BELOW"
2. Telephone/data: "CAUTION TELEPHONE LINE BURIED BELOW"

D. Manufacturer: Utility Safeguard, LLC.

2.13 ONE-LINE DIAGRAM

A. Provide a one-line suitably protected on the inside of the equipment cabinet door.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive identification products for compliance with installation tolerances and other conditions affecting performance of the identification products. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION - GENERAL

A. Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

1. Coordinate installation of identifying devices with location of access panels and doors.
2. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Install electrical identification products only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

D. Clean surface where electrical identification product is to be placed.

E. Use manufacturer's recommended adhesive for engraved tags and nameplates.

F. Place electrical identification products centered and parallel to equipment lines.

3.3 COMPONENT IDENTIFICATION TAGS

A. Install component identification tag [as indicated on the Drawings] on the front of each piece of electrical equipment including switchgear, transformers, switchboards, panelboards, motor control centers, motor controllers, safety switches, and enclosed circuit breakers.

B. Position tags so they can be read from floor or ground.

3.4 EQUIPMENT NAMEPLATES

A. Install equipment nameplate or nameplates [as indicated on the Drawings] on the front of each piece of electrical equipment including switchgear, transformers, switchboards, panelboards, motor control centers, motor controllers, safety switches, and enclosed circuit breakers.

B. Circuit directory information Category I nameplates may be omitted from equipment which receives an arc flash and shock hazard warning label that includes the required circuit directory information.

C. Position nameplates so they can be read from floor or ground.

3.5 OUTLET LABELS

A. Install outlet label on outside of device cover for each receptacle outlet and light switch.

3.6 WIRE MARKERS

A. Install wire markers on power, control and communication conductors at each appearance in locations such as pull boxes, outlet boxes, junction boxes, panelboards, switchgear, motor control centers, controllers, safety switches, enclosed circuit breakers, and load connections.

B. Position markers so they can be read from the front of the enclosure.

3.7 VOLTAGE MARKERS

A. Install voltage markers at the following locations and position markers so they can be read from floor or ground:

1. Front of each medium-voltage transformer.
2. Front and rear of each free-standing low- voltage switchgear or switchboard section.
3. Front of each low-voltage transformer, panelboard, industrial control panel, motor control center, enclosed circuit breaker, safety switch, and motor controller enclosure, including those furnished with mechanical equipment.
4. Cover of each pull box containing low-voltage or medium-voltage conductors.
5. Each 2 inch and larger conduit longer than 6 feet; space markers not more than 20 feet on center.

3.8 WARNING SIGNS

A. Install warning signs at the following locations and position signs so they can be read from floor or ground:

1. Front of each medium-voltage transformer.
2. Front and rear of each low-voltage switchgear or switchboard section.
3. Front of each low-voltage transformer, switchboard, panelboard, industrial control panel, motor control center, enclosed circuit breaker, safety switch, and motor starter enclosure including those furnished with mechanical equipment.
4. Cover of each pull box containing exposed low or medium-voltage conductors.

3.9 ARC FLASH AND SHOCK HAZARD WARNING LABELS

A. Install arc flash and shock hazard warning labels at the following locations and position signs so they can be read from floor or ground:

1. Front of each medium-voltage transformer.

2. Front and rear of each freestanding low-voltage switchgear or switchboard section.
3. Front of each low-voltage transformer, panelboard, industrial control panel, motor control center, enclosed circuit breaker, safety switch, and motor controller enclosure, including those furnished with mechanical equipment.
4. Cover of each pull box containing exposed low or medium-voltage conductors.

B. Enter the following application-specific information in arc-flash and shock hazard warning labels based on schedules on the Drawings:

1. Arc-Flash Protection Boundary (inches) calculated in accordance with IEEE Std 1584 or NFPA 70E.
2. Arc-flash incident energy (cal/cm^2) calculated in accordance with IEEE Std 1584 or NFPA 70E.
3. Working distance (inches) selected from IEEE Std 1584 or NFPA 70E (Annex D) based on equipment type.
4. Hazard/risk category number from NFPA 70E Table 130.7(C)(9) for operations with doors closed and covers on.
5. System phase-to-phase voltage.
6. Condition that exposes worker to an electrical shock hazard.
7. Limited Approach Boundary from NFPA 70E Table 130.2(C) based on nominal system phase-to-phase voltage.
8. Restricted Approach Boundary from NFPA 70E Table 130.2(C) based on nominal system phase-to-phase voltage.
9. Prohibited Approach Boundary from NFPA 70E Table 130.2(C) based on nominal system phase-to-phase voltage.
10. Class for insulating gloves based on system voltage (e.g. Class 00 for up to 500 volts).
11. Voltage rating for insulated or insulating tools based on system voltage (e.g. 1000 volts).
12. Equipment ID code based on Drawings and including TA number, building number, and system identifier.
13. Date that hazard analysis was performed.
14. “Served from” circuit directory information including the serving equipment ID code, location (e.g. room number), circuit number, and circuit voltage/phases/wires.
15. If applicable, “serves” circuit directory information including the served equipment ID code, location (e.g. room number), circuit number, and circuit voltage/phases/wires.

3.10 WORKING SPACE FLOOR MARKERS

A. Install floor marking paint on the floor at the locations listed below to indicate the working space required by the NEC.

1. Front of each medium-voltage transformer.
2. Front of each low-voltage transformer, switchboard, panelboard, industrial control panel, motor control center, enclosed circuit breaker, safety switch, and motor controller enclosure including those furnished with mechanical equipment.

3. Any other equipment likely to require examination, adjustment, servicing, or maintenance while energized.

B. Dimensions of working space area shall be as follows:

1. Width: the greater of the width of the equipment or 30 inches.
2. Depth:
   a. 120/240-volt and 208Y/120-volt equipment: 3 feet
   b. 480-volt and 480Y/277-volt equipment with exposed live parts on one side of the working space and no live parts on the other side of the working space: 3-1/2 feet.

C. Thoroughly prepare floor surface to receive paint.

D. Paint the NEC-required working space area with alternating 3 to 6 inch wide black and white diagonal stripes.

3.11 WORKING SPACE LABELS

A. Install working space labels at the following locations only in cases where it is impractical to mark the NEC-required working space on the floor (e.g. carpeted areas).

1. Front of each medium-voltage transformer.
2. Front of each low-voltage switchgear or switchboard section and rear of each freestanding low-voltage switchgear or switchboard section.
3. Front of each meter enclosure, low-voltage transformer, panelboard, industrial control panel, motor control center, enclosed circuit breaker, safety switch, and motor controller enclosure, including those furnished with mechanical equipment.
4. Any other equipment likely to require examination, adjustment, servicing, or maintenance while energized.

B. Position labels so they can be read from floor or ground:

3.12 UNDERGROUND WARNING TAPE

A. Install underground warning tape in trench above underground conduit, 1 foot below ground surface.

3.13 ONE-LINE DIAGRAM CABINET

A. Install one-line diagram cabinet in the main electrical room of the Utility Building.

B. Install cabinet in accordance with the manufacturer’s instructions.

1. Electrical one-line diagram of system

END OF SECTION

SECTION 26 2816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Safety switches
B. Fuses
C. Enclosed circuit breakers
D. Fractional horsepower motor disconnects

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 3000 Submittal Procedures:

1. Product Data: Submit manufacturer's technical data for each type of safety switch and enclosed circuit breaker, including data proving that materials comply with specified requirements. Provide catalog sheets showing voltage and current ratings, short circuit ratings, dimensions, and enclosure details.
2. Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
3. Certification: Submit certification and backup information that safety switches and enclosed circuit breakers can perform required functions after a design earthquake as specified in "SERVICE CONDITIONS" below.
   a. Safety switches and enclosed circuit breakers designated with I_p greater than 1.0 shall be certified by the manufacturer to withstand the total lateral seismic force and seismic relative displacements specified in the International Building Code (IBC) or ASCE 7 – Minimum Design Loads for Buildings and Other Structures.
   b. Manufacturer’s certification shall be based on shake table testing or experience data (i.e., historical data demonstrating acceptable seismic performance), or by more rigorous analysis providing for equivalent safety.
   c. Required response spectra shall exceed 1.1 times the in-structure spectra determined in accordance with IBC AC156 – Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.

1.3 QUALITY ASSURANCE

A. Comply with the National Electrical Code (NEC) for components and installation.
B. Provide safety switches and circuit breakers that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

C. Comply with the following standards as applicable:
   1. NEMA AB 3 – Molded Case Circuit Breakers and Their Application
   2. NEMA FU 1 Low Voltage Cartridge Fuses
   3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
   4. UL 50 - Enclosures for Electrical Equipment.
   5. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

1.4 RECEIVING, STORING AND PROTECTING

A. Receive, inspect, handle, and store safety switches and enclosed circuit breakers according to the manufacturer's written instructions and NECA 1 Standard Practices for Good Workmanship in Electrical Construction (ANSI).

B. Examine each circuit breaker to verify that it is genuine, new, and unaltered. Report any suspect/counterfeit circuit breakers. Indicators of suspect/counterfeit molded-case circuit breakers include the following:
   1. Missing date code.
   2. Date code is older than two years, or style is no longer manufactured.
   3. Factory seals broken or removed.
   4. Mislabeled or over-labeled to change size or type.
   5. Non-English text in labels.
   6. Missing or suspect UL sticker; CE is not an acceptable NRTL.
   7. Low quality labeling and/or misspelled words on labels.
   8. Outdated manufacturer’s label or logo, or refurbisher’s name on label.
   9. Not received in original, sealed packaging.
   10. Screwdriver or wrench marks on terminals.
   11. Handle modified to change ampere rating.
   12. Contradicting amperage, voltage, or interrupting ratings.

1.5 SERVICE CONDITIONS

A. Provide safety switches and enclosed circuit breakers that will perform satisfactorily in the following service conditions:
   1. Elevation of 6500 feet above sea level.
   2. Maximum ambient temperature of 104 °F.
   3. 24-hour average temperature not exceeding 86 °F.
   4. Maximum solar heat gain: 110 W/sq./ft.
   5. International Building Code / ASCE 7 seismic criteria:
      a. Seismic Design Category = D
      b. S_{DS} = spectral acceleration, short period = 0.75g
      c. S_{D1} = spectral acceleration, 1-second period = 0.64g
      d. a_p = component amplification factor = 2.5
      e. R_p = component response modification factor = 6.0

1.6 EXTRA MATERIALS

A. Provide one spray can of touch-up paint that matches finish of switches and enclosed circuit breakers finish.

B. Provide a spare set of three fuses of each type and size installed in fused safety switches.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01 2500, Substitution Procedures.

2.2 SAFETY SWITCHES

A. Provide NRTL-listed, NEMA KS 1 Type HD safety switches with ratings and number of poles as indicated on the Drawings or as required by the NEC.

B. Safety switches used as service equipment shall be NRTL labeled for the application.

C. Enclosure type shall be in accordance with NEMA KS 1 and as required by the conditions of installation and use.

D. Fusible safety switches shall have rejection clips for NEMA FU 1, Class R fuses. Provide fuse pullers in 30, 60, and 100 ampere fusible safety switches.

E. Each safety switch shall have an equipment ground bar.

F. Furnish a neutral bar for each safety switch used on a circuit that includes a grounded “neutral” conductor.

G. Each safety switch shall have a factory-installed cover-mounted viewing window positioned over the blades to allow visual verification of ON-OFF status.

H. Provide auxiliary electrical interlock switches with safety switches as indicated on the Drawings or as required by the application.

I. Each safety switch shall have provisions for padlocking in the OFF position.

J. Manufacturer: Square D “Class 3110”.

2.3 FUSES

A. Provide NRTL-listed, NEMA FU 1 Class R fuses for fusible safety switches as indicated on the Drawings, required by the NEC, or required by the manufacturer of served equipment.

B. Size fuses in accordance with NEC requirements based upon load supplied.

C. Provide a cabinet for spare fuses.

D. Manufacturer: Bussman “LPN-RK_SP” (250 V), “LPS-RK_SP” (600 V), and “SFC-FUSE-CAB”

2.4 ENCLOSED CIRCUIT BREAKERS

A. Provide, enclosed molded-case circuit breakers with ratings as indicated on the Drawings or as required by the NEC.

B. Enclosed molded-case circuit breakers shall be NRTL-listed to UL 489.

C. Multi-pole circuit breakers used on 480-volt or 480Y/277-volt systems shall be 600 V rated.

D. Enclosed circuit breakers used as service equipment shall be NRTL labeled for the application.

E. Enclosure type shall be in accordance with UL-50 and as required by the conditions of installation and use.

F. Each enclosed circuit breaker shall have an equipment ground bar.

G. Furnish a neutral bar for each enclosed circuit breaker used on a circuit that includes a grounded “neutral” conductor.

H. Enclosed circuit breakers rated 100 amperes and larger shall be suitable for use with crimp-on compression lugs.

I. Provide enclosed circuit breakers with shunt trips as indicated on the Drawings or as required by the application.

J. Each enclosed circuit breaker shall have a permanently-installed provision for padlocking in the OFF position.

1. Furnish handle lock-off device that will accept a 1/4-inch padlock shackle.

2. Securely attach the device to the circuit breaker case; the attachment shall not depend on a friction fit or the presence of the enclosure front for the handle lock-off device to remain in place and be functional.

K. Manufacturer: Square D “Class 610” enclosure with F, K, L, or M frame circuit breaker.

2.5 FRACTIONAL HORSEPOWER MOTOR DISCONNECTS

A. Provide general purpose, Class A, manually-operated, full voltage controllers as disconnects for AC fractional horsepower motors.

B. Conform to the requirements of NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

C. Enclosure type shall be in accordance with UL-50 and as required by the conditions of installation and use.

D. Controller shall have a thermal overload unit, red pilot light, and toggle operator.

E. Provide handle guard with provision for padlocking in the OFF position.

F. Manufacturer: Square D “Class 2510”.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive safety switches and enclosed circuit breakers for compliance with installation tolerances and other conditions affecting performance of the product. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install safety switches and enclosed circuit breakers where indicated on the Drawings and according to manufacturer's instructions, NECA 1, and the NEC. Have the manufacturer’s installation instructions available at the construction site.

B. Install each safety switch and enclosed circuit breaker so the interlock bypass will be accessible.

C. Provide supports and seismic anchorage in accordance with the manufacturer’s installation instructions and Section 26 0529, Hangers and Supports for Electrical Systems.

D. Ground and bond safety switches and enclosed circuit breakers as required in Section 26 0526, Grounding and Bonding for Electrical Systems.

E. Install conduits as required in Section 26 0533, Raceways and Boxes for Electrical Systems.

F. Install conductors as required in Section 26 0519, Low Voltage Electrical Power Conductors and Cables.

1. Use compression type lugs to connect all service, feeder, and branch circuit cables to enclosed circuit breakers rated greater than 100 amperes.
2. Tighten electrical connectors and terminals to the manufacturer’s published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

G. Install fuses in fusible safety switches as indicated on the Drawings or as required to match installed motor or load characteristics. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

H. Install spare fuse cabinet in the main electrical room.

3.3 IDENTIFICATION

A. Identify safety switches and enclosed circuit breakers and install warning signs and arc-flash warning labels as required in Section 26 0553, Identification for Electrical Systems.

B. Provide permanent indication of trip rating of each enclosed circuit breaker or fuses installed in each enclosed switch that will be visible without opening cover and exposing energized conductors.

C. Mark floor in front of safety switches and enclosed circuit breakers to show NEC required working space according to Section 26 0553, Identification for Electrical Systems.

3.4 FIELD QUALITY CONTROL

A. Clean interior and exterior of safety switches and enclosed circuit breakers.

B. Verify that ratings for safety switches and enclosed circuit breakers match values indicated on the Drawings.

C. Verify proper torque of accessible bus connections and mechanical fasteners after installing safety switches and enclosed circuit breakers.

D. Coordinate inspections and tests with those required by Section 26 0813, Electrical Acceptance Testing.

E. After completing installation, cleaning, and testing, touch-up scratches and mars on finish to match original finish.

END OF SECTION