

WESTCHESTER COUNTY HEALTHCARE CORPORATION
WESTCHESTER MEDICAL CENTER
BHC GENERATOR RETIREMENT
CONTRACT CMC-14329

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DIVISION 26**

DIVISION 26

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SECTION 26 05 02

ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.

1.2 DEFINITIONS

- A. The definitions of General Conditions of this specification also apply to Divisions 26 Contract.
- B. "Contract Documents" constitute the drawings, specifications, general conditions, project manuals, etc., prepared by Engineer (or other design professional in association with Engineer) for contractor's bid or contractor's negotiations with the Owner. Divisions 26 drawings and specifications prepared by the Engineer are not construction documents.
- C. "Construction Documents", "construction drawings", and similar terms for Divisions 26 Work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer's contract documents. These specifications detail the contractor's responsibility for "Engineering by Contractor" and for preparation of construction documents.
- D. "(N)" indicates "new" equipment to be provided under this contract.
- E. "(E)" indicates "existing" equipment on site which may or may not need to be relocated as a part of this work.
- F. "(R)" indicates existing equipment to be relocated as part of this work.
- G. "Furnish" means to "supply" and usually refers to an item of equipment.
- H. "Install" means to "set in place, connect and place in full operational order".
- I. "Provide" means to "furnish and install".
- J. "Equal" or "Equivalent" means "meets the specifications of the reference product or item in all significant aspects." Significant aspects shall be as determined by the Architect/Engineer.
- K. "Work by other(s) divisions"; "re: _____ Division", and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractor's sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Architect/Engineer before submitting bid.
- L. By inference, any reference to a "contractor" or "sub-contractor" means the entity, which has contracted with the Owner for the work of the Contract Documents.
- M. "Engineer" means the design professional firm, which has prepared these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).

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- N. "Conduit" includes, in addition to pipe, all fittings, hangers and other accessories related to such conduit.
- O. "Concealed" means hidden from sight as in chases, furred spaces shafts, hung ceilings, or embedded in construction.
- P. "Exposed" means, "not concealed" as defined above. Work in trenches, crawl spaces, and tunnels shall be considered "concealed" unless otherwise specifically noted.
- Q. "Governmental" means all municipal, state and federal governmental agencies.
- R. Where any device or part of equipment is herein referred to in the singular number (such as "the conduit"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the Drawings.
- S. "Electrical Contractor" means the Contractor doing Electrical work.
- T. "Security Contractor" means the Contractor doing Security work.
- U. "Fire Alarm Contractor" means the Contractor doing Fire Alarm work.

1.3 DESCRIPTION OF WORK

- A. The Specifications and the accompanying drawings are intended to secure the provisions of all material, labor, equipment, and services necessary to install complete, tested, and ready for operation the Electrical Systems in accordance with the Specifications and Drawings. The use of the term "provide" shall mean "furnish and install" throughout these specifications and drawings. All systems shall be complete with necessary appurtenances and minor auxiliaries, including pull boxes, offsets to clear interferences, and supports which are not shown but are needed to make each system complete in every respect. All work described in the Specifications and not shown on the Drawings, or vice versa, shall be furnished in complete working order. If mention has been omitted of any item of work or material, necessary for completion of the system, then such items must be and are hereby included. The scope of this project includes, but is not limited to the following work:

1. Raceways and installation components.
2. Wire and Cable.
3. Fuses.
4. Safety and disconnect switches.
5. Control equipment.
6. Emergency generators.
7. Transfer switches.
8. Power, control and alarm wiring systems.
9. Grounding system.
10. Testing.
11. Alternate prices.
12. Modification to existing electrical distribution.
13. Demolition.
14. Furnishing of access doors (see Special Conditions - Article 33).
15. Furnishing and setting of all sleeves through the floors, roof and wall, where required including waterproofing and fireproof sealing and cap flashing.
16. Excavation and backfill (excavation in rock shall be included). All concrete work for pads (including housekeeping pads), bases for outdoor lighting fixtures, and conduit

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envelopment shall be included.

17. Hardware, such as inserts, bolts, etc., associated with concrete pads.
18. Cutting associated with electrical work.
19. Prime painting, where required for electrical equipment and installation.
20. Removal of existing electrical work in accordance with Architectural Demolition Scheme or as directed and required. Restoration of electrical service in affected adjoining areas which are to continue to function.
21. Provision for temporary light and power.
22. Installation and wiring of starters and controllers.
23. As-built drawings.

1.4 REGULATORY REQUIREMENTS

- A. All materials shall conform with the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of the Architect and at no additional cost to the Owner.
- B. The latest editions of the following standards are minimum requirements.
 1. Underwriters' Laboratories, Inc. (UL)
 2. National Electrical Manufacturer's Assoc. (NEMA)
 3. American National Standards Institute (ANSI)
 4. Institute of Electrical and Electronic Engineers (IEEE)
 5. International Electrical Testing Association (NETA)
 6. Insulated Cable Engineer's Association (ICEA)
- C. All work and materials shall comply with latest rules, codes and regulations including, but not limited to the following:
 1. OSHA.
 2. National Fire Codes of National Fire Protection Assoc. (NFPA)
 3. National Electrical Safety Code (NESC, ANSI C2)
 4. National Electrical Code (2014 Edition) with **Valhalla** city, county and state Amendments.
 5. International Building Code (2015 Edition with city, county and state Amendments.
 6. Americans With Disabilities Act (ADA).
 7. All applicable Federal, state and local laws, code amendments and regulations.
- D. Code compliance is mandatory. Nothing in these drawings and specifications permits work not conforming to these codes.
- E. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, Contractor shall be responsible for all work required to open and restore the concealed area including all required modifications.
- F. Contradictions: Where Codes are contradictory, follow the most stringent. Architect/Engineer shall determine which is most stringent.

1.5 CONTRACT DOCUMENTS

- A. Drawings indicate general arrangement of circuits and locations of outlets, conduit, and other work. Information shown on drawings is as accurate as planning can determine, but not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all architectural, structural and mechanical drawings, and adjust all work to

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conform to all conditions shown therein. Architectural drawings shall take precedence over all other drawings. Discrepancies between different drawings or between drawings and specifications or regulations and codes governing installation shall be brought to attention of the Architect.

- B. Light and power and system riser diagrams and schematic diagrams generally indicate equipment connections to be used for various systems. System conduit and wiring shall be as required for actual systems installed on this project. Provide all work shown on diagrams whether or not it is duplicated on the plans.
- C. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer in writing during the Bidding Period of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
- D. Follow Drawings and Specifications where they are superior to Code requirements. The more stringent of plans and drawing shall apply.

1.6 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 "Submittals" to a scale of $\frac{1}{4}'' = 1'-0''$ or larger; detailing major elements, components, and systems of electrical equipment (i.e., all transformer vaults, switchgear rooms, generator rooms, electrical rooms and telephone rooms) and materials in relationship with other systems, installations, and building components. Where equipment is located outdoors, prepare shop drawings indicating electrical equipment locations and exterior elements in the equipment areas. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:
 - 1. Indicate the proposed locations of major raceway systems, and materials. Include the following:
 - a. Exterior wall and foundation penetrations.
 - b. Fire-rated wall and floor penetrations.
 - c. Support details.
 - d. Sizes and location of required concrete pads and bases.
 - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 - 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installation.

1.7 RECORD DRAWINGS

- A. Refer to Division 1 for additional requirements.
- B. Maintain a blue-line set of Electrical Contract Drawings in clean, undamaged condition, for mark-up of installations which vary from the Contract Drawings. These drawings shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses. This set shall be made available for inspection by the Engineer or Architect at all times.
- C. Upon completion of the contract and before final payment is authorized, the contractor shall deliver the Owner a set of computerized "as built" capable of interfacing with AutoCAD

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software. Drawings shall have to show to scale, where applicable, all work including equipment, controls, etc., as actually installed.

- D. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout." In addition to the requirements specified in Division 1, indicate installed conditions for:
 - 1. Major raceway systems, size and location, for both exterior and interior and locations of handholes and conduit stub-up locations.
 - 2. Panelboard circuit directories reflecting all field changes.
 - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 4. Results of all testing performed as specified in the specification.
 - 5. Certification of inspection from authorities having jurisdiction.
- E. Record the locations and invert elevations of underground installations.

1.8 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Division 1 for additional requirements.
- B. Submission:
 - 1. O&M manuals submitted for review shall be submitted as PDF documents, one document per manual.
 - 2. For final submission to owner, O&M Manuals shall be submitted as hard copies and digital PDF copies.
 - 3. Bind each hard copy Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings. Mark the back spine of each binder with system identification and volume number.
- C. Requirement Contents:
 - 1. Manuals shall have index with tab dividers for each submittal section identifying all equipment and materials installed on the project including a local supplier for replacing a specific piece of equipment.
 - 2. Introduction - Explanation of manual and its use.
 - 3. Description of system or equipment.
 - a. Complete schematic drawings of all systems.
 - b. Functional and sequential description of all systems.
 - 4. Systems operations:
 - a. Operation procedures.
 - b. All posted instruction charts.
 - 5. Maintenance
 - a. Systems trouble-shooting charts
 - b. Procedures for checking out functions.
 - c. Recommended list of spare parts.
 - 6. Listing of Manufacturers
 - 7. Manufacturer's Data (where multiple model, type and size listings are included, clearly and conspicuously indicate those that are pertinent to this installation).
 - a. Description - literature, drawings, illustrations, certified performance charts, technical data, etc.

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- b. Operation
 - c. Maintenance - including complete trouble-shooting charts
 - d. Parts list
 - e. Names, addresses and telephone numbers of recommended repair and service companies.
 - f. Guarantee data.
8. Provide certificates for such items of equipment which have warranties in excess of one year.
 9. Provide test results for each specification section identified herein.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Protection of Equipment:
 1. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, rain, sleet, or dust. Large diameter cables may be stored on reels outside; however, all cable ends shall be waterproofed and the reels covered with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened, and made impervious to the elements.
 2. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers, or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
 3. Equipment damaged as a result of the above conditions shall be properly repaired at the contractor's expense or shall be replaced at the contractor's expense, if in the opinion of the Engineer, the equipment has been damaged to such an extent that it cannot operate properly after repairs are made.
 4. All electrical enclosures exposed to construction damage such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs, and pipe covering compound splashes, shall be completely covered and protected against damage.
 5. In the event leakage into the building of any foreign material or fluid occurs or may occur, the contractor shall take all steps as described above to protect any and all equipment.
 6. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape, and insulation removed in order to make the connection.

1.10 SAFETY AND INDEMNITY

- A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. See also General Conditions.

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- B. No act, service, drawings review or construction review by the Architect or Engineer, is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

1.11 WARRANTIES

- A. The warranty period is generally one year after Date of Acceptance.
 - 1. During this period, provide labor and materials as required to repair or replace defects in the electrical systems at no cost to the Owner. Provide certificate with O & M manual submittal which guarantees same day service response to the Owner's call for such warranty service.
 - 2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies of O & M manual. Such equipment shall include:
 - a. Emergency system including transfer switches
 - 3. Provide extended manufacturers warranties to cover one full year from Date of Acceptance if standard manufacturers' warranty ends any time prior to that date.

1.12 LIABILITY

- A. The Contractor shall assume full responsibility for laying out his work and for any damage caused to the Owner or other sub-contractors by improper location or carrying out of his work.
- B. The Contractor shall provide proper guards for prevention of accidents, and provide and maintain any other necessary construction required to secure safety of life or property to secure such protection.

1.13 BYPASS CONNECTIONS

- A. The Contractor shall include all costs for removals and relocations in the Contract. These costs shall include work described in the Specifications and shown on the Drawings with allowances for normal unforeseen difficulties when concealed work has been opened. A minimum of 3 bypass connections shall be included. Each bypass connection shall consist of 50 feet of 3 inch EMT conduit with 4 #500 AWG and 1#3 AWG ground conductors, (2) junction boxes, (4) 90 degrees bends, and all appurtenances as required for connections; bypass connections would be installed 11 feet high in congested area, and be supported from structure above. Include cost of cutting and removal of feeder to be bypassed. Bypass connection installation shall be priced on an overtime schedule basis.

1.14 SHUTDOWNS

- A. When installation of a new system or reconnection of an existing system requires the temporary shutdown of an existing operating system, the connection into the existing system shall be performed at such time as designated by the Owner.
- B. The Owner shall be notified of the estimated duration of the shutdown period (3) weeks in advance of the date the work is desired to be performed.
- C. Work shall be arranged for continuous performance, including overtime, at no extra cost to the Owner to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.15 COORDINATION WITH EXISTING OCCUPIED AREAS

- A. Minimize disruptions to operation of building systems in occupied areas.
- B. Provide temporary connections to prevent long disruptions.
- C. Provide multiple crews, premium time labor and/or shift labor to reduce duration of work and impact on the facility.
- D. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such regular time or at overtime when designated by the Owner. Assume all connections to existing operational systems will be on premium time, provide a credit for all work allowed to occur on normal time.

1.16 ENGINEERING BY CONTRACTOR

- A. The construction of this work requires the Contractor to perform certain design activities with regard to several of the Contract systems or subsystems that can only be fully ascertained with regard to the prevailing site field conditions during construction activities. All such designs and related activities shall be the complete responsibility of the Contractor. Where these design activities require engineering, it is the responsibility of the Contractor to engage the service of a licensed New York State Professional Engineer experienced in the areas related to the design activities performed by the Contractor.
- B. Systems or subsystems which require engineering responsibility by the contractor include, but are not limited to:
 - 1. Any system not fully detailed on the drawings.
 - 2. Equipment supports, not fully detailed in the drawings.
 - 3. Conduit hangers and anchors not specified in these documents, or cataloged by the manufacturer.
 - 4. Vibration isolators and seismic restraints.
 - 5. Miscellaneous steel as required.
 - 6. Equipment supports, hangers.
 - 7. Pull box and splice box quantities and sizes.
- C. Contractor's design responsibility shall include system design, any required calculations to support system design, any compliance documents or certifications by any governing body up to and including replacement of design engineer with a different engineer of record, retained and paid by the contractor, as determined by authorities or original design engineer.
- D. Contractor shall complete all controlled or special inspections and file all required paperwork in a timely manner. Professional engineer retained by contractor to serve as "special inspector" shall meet all requirements for special inspector as determined by the authority having jurisdiction.

1.17 ACCESSIBILITY AND MEASUREMENT

- A. All work shall be installed so as to be readily accessible for operation, maintenance and repair. Minor deviations from the plans may be made to accomplish this, subject to the approval of the Engineer/Architect.
- B. Before ordering any material or doing any work, the Contractor shall verify all measurements at the Building, and shall be responsible for the correctness of same as related to the work under

this Contract.

1.18 NAMES AND TRADE NAMES

- A. Where trade and manufacturers' names are specified or indicated on the Drawings, they are intended to indicate the standard of material or articles required. This shall not remove the responsibility of the Contractor from verifying the equipment's compliance with all rules and regulations governing the use of such equipment. No purchase of any equipment shall be done without written authorization, if such equipment will not abide with all rules and regulations, covering its intended use.

1.19 MISCELLANEOUS

- A. For watchman, staging, scaffolding, insurance, bond, pumping, rubbish removal, access to work areas, storage on site, and the like, refer to Division 1, General Requirements of these specifications.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All equipment and materials installed shall be new, unless otherwise specified.
- B. All major equipment components shall have manufacturers' name, address, model number and serial number permanently attached in a conspicuous location.
- C. All equipment shall be UL listed and bear the UL label.

2.2 GENERAL SUBMITTAL REQUIREMENTS

- A. Coordination and Sequencing:
 - 1. After receipt of notice to proceed, the Contractor shall submit to the Architect a typed list of submittals and the scheduled date of submission. List shall include submittal number, section number and scheduled date of submission. Submittals shall be grouped and submitted in no more than ten complete packages.
 - 2. The contractor shall not submit any shop drawings or product data that does not comply with the contract documents. Prior to submitting shop drawings, review submittal for compliance with Contract Documents and place a stamp or other confirmation thereon which states that submittals have been reviewed. Submittals without such verification will be returned disapproved without review.
 - 3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
 - 4. The Contractor shall submit shop drawings with such promptness as to cause no delay in his own work or that of another contractor.
- B. Preparation of Submittals:
 - 1. The Contractor shall submit for approval by the Architect data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone

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will not be acceptable. Provide complete electrical characteristics for all equipment.
Submit product submittals on items as outlined in sections hereinafter.

2. Product submittals shall be made by specification section. All items of a section, requiring submission, shall be submitted together at one time in a single PDF document. If two or more sections require inter-coordination (e.g., emergency generator and transfer switch; short circuit study, electrical room layouts and electrical switchboards), they shall be submitted at the same time.
3. Each individual submittal items within a PDF document shall be marked to show section number which pertains to the item.
4. Provide the following information in each PDF document: project name, Contractor, Subcontractor, submittal name, date of submission, specification section, and information to distinguish it from other submittals.
5. Submittals not presented in a neat and legible fashion will be returned "Without Action."
6. Submittals shall show Contractor's executed review and approval marking. Submittals which are received from sources other than through Contractor's office will be returned "Without Action."
7. Provide space for Architect's "Action" marking.

C. Substitutions

1. Refer to the General Conditions, which governs "Substitution" of specified equipment or materials.
2. Indicate any portions of work which deviate from the Contract Documents.
 - a. Explain the reasons for the deviations.
 - b. Show how such deviations coordinate with interfacing portions of other work.
3. Where substitution of materials alters space requirements indicated on the drawings, submit shop drawings indicating proposed layout of space, all equipment to be installed therein and clearances between equipment (i.e., electrical rooms). All clearances required by the National Electrical Code and applicable state and local regulations must be maintained.

D. Review Process

1. The Architect reserves the right to require a sample of any equipment to be submitted for approval and to retain its possession.
2. Refer to the individual sections for identified equipment and material for which submittals are required. In addition, provide shop drawings and product data on the following equipment:

Division 26

Wires and Cables
Grounding
Supporting Devices
Raceways
Electrical Boxes and Fittings
Underground Manholes
Vibration Isolation Systems
Electrical Identification
Fuses
Transfer Switches

Do not submit on equipment or materials not requested in the specifications.

3. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
4. The shop drawing and product data review stamp notation requirements are defined as follows:
 - a. "REVIEWED:" The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades is the responsibility of the contractor.
 - b. "FURNISH AS PER COMMENTS:" The reviewer indicated items observed that were not in compliance with the contract documents. The contractor shall not resubmit, but shall make corrections and provide corrected documents with the "Record Drawings."
 - c. "REVISE AND RESUBMIT:" The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal does not relieve the contractor from meeting project schedules.
 - d. "REJECTED:" The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal does not relieve the contractor from meeting project schedules.
5. If shop drawings are submitted and returned as "REVIEWED" or "FURNISH AS PER COMMENTS" and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
6. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase "RESUBMITTAL NO. _____."

Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

2.3 PROTECTION, MAINTENANCE AND PRODUCT HANDLING OF ELECTRICAL EQUIPMENT

- A. Electrical equipment shall be delivered and stored at the site, properly packed and crated until finally installed. Store materials in spaces as designated by the General Contractor. Investigate each space through which equipment must be moved. If necessary, equipment shall be shipped from manufacturer in crated sections of size suitable for moving through restricted spaces.
- B. Uninstalled and installed equipment and materials shall be adequately protected against loss or stealing, damage caused by water, paint, fire, plaster, moisture, acids, fumes, dust or other environmental conditions, or physical damage, during delivery, storage, installation and shutdown conditions. This Contractor shall replace any damage or stolen material without extra cost to the Owner.
- C. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions of temperature in area of moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.
- D. This Contractor shall be responsible for the maintenance of all equipment and systems installed, until final acceptance by the Architect and the Owner. The Operation of the equipment by the Owner does not constitute an acceptance of the work. Work will be accepted

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only after the Contractor has adjusted his equipment, demonstrated that it fulfills the requirements of the Drawings and Specifications, and has furnished all required certificates.

- E. This Contractor shall guarantee in writing to the Owner that all work installed by him shall be free of defects in workmanship and materials and that all apparatus will develop the capacities and characteristics as indicated, and that, if during a period of one year from date of final approval of work by the Architect, any defects in workmanship, materials or performance appear, he will remedy them without any cost to the Owner. Guarantee requirements shall consist of the foretasted and other requirements, as established under applicable contract documents.
- F. Provide effective protection against damage for all material and equipment during shipment, and storage at the Project Site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.
- G. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.
- H. Protect all rough and finished floors and other finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor covering. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.
- I. Have materials delivered to site. Unload and store materials in designated location, and protect from damage. Deliver materials to their point of installation.
- J. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

2.4 NAMEPLATES

- A. Furnish a nameplate for each separately installed feeder, switch and circuit breaker, each individual panel, transformer, disconnect switch, push-button station and equipment enclosure.
- B. Unless otherwise noted, nameplates shall be black laminate with white letters of uniform size consisting of reasonably large caps, easily visible.
- C. Inscriptions shall consist of name and number of equipment as shown on the Drawings and as approved by the Architect.

PART 3 – EXECUTION

3.1 CONDITIONS AT SITE

- A. Visit to site is required of all bidders prior to submission of bid. All bidders will be held to have familiarized themselves with all discernible conditions, and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not. Verify all grades, elevations, dimensions, and clearances at the site.

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- B. Lines of other services and/or equipment that are damaged as a result of this work shall promptly be repaired at no expense to the Owner.
- C. Examine all work prepared by others to receive the work of this Section and report any defects affecting installation to the General Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.
- D. Existing conditions, equipment, material, and sizes are shown for reference only. Verify existing conditions and bring any discrepancies to Architect's attention in writing prior to submission.

3.2 LICENSES, FEES AND PERMITS

- A. Arrange for required inspections and pay all license, permit and inspection fees. Furnish a certificate of final inspections and approvals from local authority having jurisdiction over electrical installation and deliver to Architect.
- B. This work shall include the procurement of and payment for all permits, certificates and fees for the performance of the electrical work in compliance with codes, applicable laws and municipal regulations including those from local utilities for services.

3.3 MATERIAL, WORKMANSHIP, AND CONTRACTOR'S QUALIFICATIONS

- A. Only professional quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
- B. Provide foreman in charge of this work at all times. Foremen for this work shall have had experience in installing not less than 5 such electrical systems of equal or greater complexity.
- C. Where specifications call for an installation to be made in accordance with manufacturers' recommendations, a copy of such recommendations shall at all times be kept in job superintendent's office.
- D. All material shall be new and of the best quality and shall have the Underwriters Laboratories label attached. The Label shall be of the type for the intended application. The work throughout shall be executed in the best and most thorough manner under the direction of, and to the satisfaction of the Architect who will interpret the meaning of the Drawings and Specifications. The Architect shall have the power to reject any work and materials which, in his opinion, is not in full accordance therewith.
- E. If, after installation, operation of the equipment proves to be unsatisfactory to the Owner by reason of defects, errors or omissions, the Owner reserves the right to operate equipment until it can be removed from service for correction by Contractor. Contractor shall pay for damages to work of other trades caused by this defective equipment and its replacement.

3.4 SUPERVISION AND COORDINATION

- A. Contractor shall coordinate work of this Division with other trades to avoid conflict and to provide rough-ins and other connections for equipment furnished under other divisions that require electrical connections. Inform other trades of required clearances of accesses for or around electrical equipment to maintain serviceability and code compliance.
- B. The work of this Section shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of each respective work wherein it may be

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interrelated with that of this Contract so that generally all construction work can proceed in its natural sequence without unnecessary delay. All communications of a coordinating nature to the Architect shall be via the General Contractor.

- C. Examine all Architectural, Structural, Heating, Ventilating and Air Conditioning, Sprinkler and Plumbing Drawings relating to this Project, and verify all governing conditions at the site and become fully informed as to the extent and character of the work required and its relation to other work in the building. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or work to be done.
- D. Scaled and figured dimensions with respect to the items are approximate only; sizes of equipment have been taken from typical equipment items of the class indicated. Before proceeding with work, the Contractor shall carefully check all dimensions and sizes and shall assume full responsibility for the fitting-in of equipment and materials to the building and to meet architectural and structural conditions. Discrepancies shall be reported to the Architect in ample time to prevent delays or unwarranted changes to work.
- E. Coordinate work with other disciplines. Confer with other contractors whose work might affect this installation, and arrange all parts of this work and equipment in proper relation to the work and equipment of others, with the building construction and with architectural finish so that this work will harmonize in service, appearance, and function.
- F. Exposed piping shall be installed to provide the maximum amount of headroom but in no case shall piping be installed less than seven feet (7'-0") above the finished floor. Piping installed in areas where hung ceilings or other furred spaces are indicated shall be installed concealed.
- G. The Contractor is referred to the Architectural drawings for locations and types of hung ceilings and furred spaces.
- H. The Contractor shall have competent supervision on the site at all times to layout, check, coordinate and supervise the installation of all electrical work and be responsible for the accuracy thereof. He shall plan the installation of all electrical work, giving consideration to the work of other trades to prevent interference.
- I. The Contractor shall take all field measurements necessary for this work and shall assume responsibility for their accuracy.

3.5 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of materials and labor will be provided by other contractors under other Sections of the Specifications and shall be excluded from the work to be furnished by this Contractor:
 - 1. Removing diesel fuel oil piping, underground storage tank and exhaust piping for emergency generator. Removal of silencer, daytank and flexible connections.
 - 2. Removal of day tank and transfer pump, muffler and flexible connectors.
 - 3. Base flashing for conduits passing through roof.
 - 4. Setting of access doors in walls and ceilings.
 - 5. Rough and finish patching.
 - 6. Finish painting of exposed conduits, boxes, hangers, apparatus, etc.
 - 7. Openings for sleeves in foundation walls below grade and floor slabs when noted on foundation Drawings or in foundation Specifications.
 - 8. Dewatering of trenches outside of Building.

3.6 TESTING

- A. Provide all labor, materials, and equipment necessary to make required tests. Tests shall be complete and results approved before final inspection is begun.

3.7 PROGRESS OF WORK

- A. Order progress of electrical work so as to conform to progress of work of other trades, and complete entire installation as soon as condition of building will permit. Assume any cost resulting from defective or ill-timed work performed under this Division.

3.8 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirement specified in Division 1, the following requirements apply:
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover work to provide for installation of ill-timed work.
 - b. Remove and replace defective work.
 - c. Remove and replace work not conforming to requirements of the Contract documents.
 - d. Remove samples of installed work as specified for testing.
 - e. Install equipment and materials in newly installed structures.
 - f. Upon written instructions from the architect, uncover and restore work to provide for Architect observation of concealed work.

3.9 SLEEVES

- A. Place sleeve in forms of walls, floor slabs and partitions for passage of all conduits, pipes, and ducts installed under Divisions 26. Sleeves shall be set in place a sufficient time ahead of concrete work so as not to delay that work. Install sleeves and raceways through exterior walls so as to provide a waterproof installation. All floor penetrations shall be made watertight. Conduits passing through walls shall be installed to preserve integrity of the wall rating (i.e., fire rating, sound rating, air, etc.). All penetration made through existing concrete slabs or walls shall be x-rayed and approved by Structural Engineer prior to cutting.

3.10 EXCAVATION, TRENCHING, AND BACKFILLING

- A. Perform all excavation to install conduit and duct banks indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the Architect.
- B. Grade the bottom of trenches to provide uniform bearing and support for conduits or duct bank on undisturbed soil at every point along its entire length. Tamp over depths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.

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- C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale. These materials should be free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has cover of not less than the adjacent ground but not greater than 2" above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.
- D. In addition, all excavation and backfilling shall comply with Division 2. The most stringent requirement shall apply.

3.11 LOAD BALANCE

- A. Connect branch circuits to panelboards, and panelboards to feeders so that loads are balanced among the phases within practical limits on the basis of connected load.
- B. Branch circuit numbers shown on the drawings are for identification only and do not necessarily indicate the final position of the branch circuits in the panelboards

3.12 MOISTURE-DAMP PROTECTION

- A. Wherever any electrical components such as: panels, raceways, etc will be in contact with surfaces which may become damp or wet, spacers to hold electrical work 1/4" (.006m) away from such surfaces shall be provided.

3.13 CLEANUP

- A. Remove all materials, scrap, etc., relative to electrical installations and leave premises in a clean, orderly condition. Any costs to the Owner for cleanup of site will be charged to the Contractor. At completion, all equipment, raceways, etc., shall be thoroughly cleaned and all residue removed from the inside and outside surfaces. Defaced finish shall be refinished.

3.14 TEMPORARY LIGHTING AND POWER

- A. Provide temporary emergency battery back-up, or temp generator power for lighting in stairs and corridors while permanent emergency power is off line during demolition and construction. All temporary power and lighting feeders and branch shall have over-current protection.
- B. Electrical services for temporary light and power shall be **obtained from the nearest existing normal board and extended as required. Consult the Owner prior to making any connections to existing services. OR arrange with utility company for temporary power connection or generator. Exact size of temporary power required shall be field coordinated by the contractor.**
- C. The Electrical Contractor shall furnish, install and maintain the temporary lighting and power system for all Contractors. The use of electricity shall be kept to a minimum.
- D. The Owner or Owner's Representative will pay for all energy required by the temporary lighting and power system.
- E. Provide all wiring, supports, lamp sockets, receptacle sockets and any other materials, supplies or equipment necessary for temporary light and power system.

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- F. Ground fault protection required by OSHA for temporary receptacle circuits shall be accomplished by providing branch circuit panels containing ground fault protection branch circuit breakers.
- G. Provide a grounding conductor connection to each receptacle grounding terminal. Minimum size branch circuit and ground conductors shall be No. 12 AWG.
- H. Install separate stringer circuits for lighting and receptacles. Provide one lamp socket and one duplex receptacle (or two single receptacles) for every 400 square feet of new general construction area. (Approximately 20 feet on centers). Furthermore, provide one lamp socket and one duplex receptacle every 20 feet along the peripheral walls of the construction areas for temporary conditions. Each lamp socket shall be provided with a 100 watt lamp. Replace burned out lamps as required for as long as the temporary lighting system is maintained in operation.
- I. Provide sufficient supplementary temporary lighting to permit proper execution of the work. This supplementary lighting shall consist of but not be limited to the following:
 - 1. Construction hoist landings.
 - 2. Stairways and stairway landings where existing illumination is inadequate due to alterations or construction.
 - 3. Interior rooms not covered with general construction area lighting.
 - 4. Provide temporary lighting on construction barriers if barriers block lighting in existing spaces. Provide temporary emergency lighting per code required distances if emergency lighting is obstructed by construction barriers.
- J. Provide power wiring to operate construction hoist. Provide fused disconnect switch at hoist location. Fuse size, wiring size and disconnect shall be as required.
- K. Provide 50 trailer extension cords, each 25 feet long. Cords shall be 16-3, Type SJ. 25 of the trailer cord sets shall be receptacle type ITT No. 6112 and 25 of the trailer cord sets shall be trouble light type with receptacle ITT No. J-3270.
- L. Keep the temporary lighting and power system operational commencing fifteen (15) minutes before the established starting time of that trade which starts work earliest in the morning and ending fifteen (15) minutes after the established quitting time of that trade which stops work latest in the evening. This applies to all weekdays, Monday through Friday inclusive, which are established as regular working days for any trade engaged in the work, and shall continue until Final Acceptance of the work or until these services are ordered terminated by the Owner or the Owner Representative.
- M. Any or all of the temporary services herein specified shall be disconnected, removed, or relocated when its or their use is no longer required, or if it or they should impede the progress of the work, and as requested by the Construction Manager and/or General Contractor. Should a change in location of any temporary equipment herein specified be necessary to progress the work, the contractor shall remove and relocate such equipment as directed by the Construction Manager and/or General Contractor at no additional cost to contract. The temporary equipment herein specified shall be removed and disposed of when directed by the Construction Manager and/or General Contractor.
- N. Any Contractor requiring overtime use shall reimburse the Electrical Contractor by private agreement between Contractors.

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- O. Provide construction site lighting as required or directed. This lighting shall be mounted on shanties and shall be wired on separate circuits to permit illumination from dusk to dawn.
- P. Immediately upon activation of permanent service, the contractor shall distribute temporary power from the permanent service.
- Q. It is the intent of these specifications to generally indicate to the contractor the scope and requirements of temporary light and power. It is understood that these requirements shall vary during construction as required by field conditions, etc and as directed by the Construction Manager and/or General Contractor. It shall be the responsibility of the Contractor to adjust and modify the temporary wiring requirements accordingly.

3.15 MINOR CHANGES

- A. The Owner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the Owner.

3.16 ELECTRICAL SYSTEMS OPERATIONAL TESTS, CERTIFICATION, AND DESIGN AUTHORITY ASSISTANCE

A. Testing

- 1. Refer to the individual specification sections for test requirements.
- 2. Prior to the final inspection, the systems or equipment shall be tested and reported as herein specified. Six (6) typewritten copies of the tests shall be submitted to the Architect/Engineer for approval.
- 3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers' Certifications

- 1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been installed in accordance with the manufacturers' recommendations and is operating as specified in the contract documents.
- 2. Provide manufacturers' certification for the automatic transfer system.

C. Design Authority Assistance

- 1. The Contractor shall provide personnel to assist the Architect/Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
- 2. Remove equipment covers (i.e., panelboard trims, switchboards, panelboards, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceiling shall be removed as directed for inspection of equipment installed above ceilings. Reinstall all covers or ceilings after inspection.
- 3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by Architect/Engineer.
- 4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Architect/Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the

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Architect. Refer to the appropriate specification section for additional testing requirements. Representatives of the emergency generator/automatic transfer switch and fire alarm systems are required for demonstrations.

3.17 COMMISSIONING

- A. After startup and testing of each system has been completed, the Owner shall have an independent firm conduct detailed observations of the equipment and systems to confirm compliance with the Contract Documents.
- B. The Division 26 Contractor shall include, as part of the work of his contract, costs to cover manpower, equipment, tools, ladders, instruments, etc., necessary to expedite the system performance observations.
- C. The independent firm shall develop systems, equipment checkout procedures and data forms for recording compliance of the systems to the Contract Documents, performance, and construction observation lists, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

END OF SECTION

SECTION 26 05 03

TESTING

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. Acceptance and startup testing requirements for electrical power distribution equipment and systems. Contractor shall retain and pay for the services of a recognized independent testing firm for purpose of performing inspections and tests as herein specified.
 - 1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
 - 2. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
 - 3. The tests and inspections shall determine suitability for startup and energization.
 - 4. The following equipment shall be tested and or calibrated:
 - Low Voltage Power Wires and Cables - Section 26 05 19
 - Grounding - Section 26 05 26
 - Diesel Generator Set - Section 26 32 13
 - Automatic Transfer Switch - Section 26 36 00

1.2 SUBMITTALS

- A. Provide submittal per Contract General Conditions, Division 1, and Section 26 05 02.
- B. Qualification of testing firm.
- C. Submit PDF copies of certified test reports to Engineer for approval.
- D. PDF copies of blank forms for checklists, test reports, and other related forms for Engineer's review and approval.

1.3 GENERAL REQUIREMENTS

- A. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to any acceptance testing.
- B. The Contractor shall test all lighting, low voltage relays and circuits to ensure proper operating conditions prior to acceptance testing.
- C. The Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.
- D. The Contractor shall be responsible for all final settings and adjustments on protective devices and tap changes, submitting settings to the Architect/Engineer for review.
- E. Provide a complete short-circuit study, equipment interrupting/withstand evaluation, and a protective device coordination study for the electrical distribution system described herein. This

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study shall be submitted with electrical equipment submission and electrical room layouts.

- F. The Contractor shall engage the services of a recognized corporate and financially independent testing firm for the purpose of performing inspections and tests as herein specified.
- G. The firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
- H. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- I. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.
- J. Prior to performing tests, the contractor shall notify the Architect a minimum of one week in advance, so that the Architect may schedule a representative to be present while tests are being conducted.
- K. Any defects shall be corrected at once, and the tests reconducted.
- L. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- M. The tests shall be performed by competent personnel and shall demonstrate the following:
 - 1. That all power and control circuits are continuous and free from short circuits.
 - 2. That all circuits are free from unspecified grounds.
 - 3. That all connections within panelboards are tight and do not produce excess heating.
 - 4. That the resistance to ground of all non-grounded circuits is not less than one megohm.
 - 5. That all circuits are properly connected in accordance with the applicable wiring diagrams.
 - 6. That all circuits are operable by which a demonstration shall include functioning of each control not less than three times and continuous operation of each lighting and power circuit for not less than 1/2 hour.
 - 7. That all alarm and signal systems are properly functioning.
- N. When wiring systems are "megger" tested, the insulation resistance between conductors and between conductors and grounds, based on maximum load, shall not be less than that required by Electrical Code and local authorities having jurisdiction.
- O. A digital copy of record of all test data shall be supplied to the Architect (three copies). The tests shall cover but not be limited to the following:
 - 1. Emergency equipment and distribution system.
 - 2. Emergency power communications, signaling and alarm systems.
 - 3. Power installations.
 - 4. Any part of the work called for in the Specification, or Drawings and as designated by the Engineers.
- P. If in the opinion of the engineer, the results of such tests show that the work has not complied with the requirements of the Specifications or Drawings, the Contractor shall make all additions or changes necessary to put the system in proper working condition and shall pay for all the

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expenses and for all subsequent tests which are necessary to determine whether the work is satisfactory. Any additional work or subsequent tests shall be carried out at the convenience of the Owner, prior to final payment.

1.4 QUALIFICATIONS OF TESTING FIRM

- A. The testing firm shall be a recognized corporate and financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association (NETA).
- D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing and engineering services. All studies, tests, and reports shall be sealed by a registered electrical professional engineer with a current **New York** stamp.
- F. The testing firm shall submit proof of the above qualifications with bid documents, when requested.
- G. The terms used herewith, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

1.5 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
 - 1. National Electrical Manufacturer's Association - NEMA
 - 2. American Society for Testing and Materials - ASTM
 - 3. Institute of Electrical and Electronic Engineers - IEEE
 - 4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1991
 - 5. American National Standards Institute - ANSI C2: National Electrical Safety Code
 - 6. State and City of **[SPEC WRITER: ADD CITY]** _____ Codes and Ordinances
 - 7. Insulated Cable Engineers Association - ICEA
 - 8. Association of Edison Illuminating Companies - AEIC
 - 9. Occupational Safety and Health Administration - OSHA
 - 10. National Fire Protection Association - NFPA
 - a. ANSI/NFPA 70: National Electrical Code
 - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
 - d. ANSI/NFPA 78: Lightning Protection Standard
 - e. ANSI/NFPA 101: Life Safety Code

- B. All inspections and tests shall utilize the following references:
1. Project design specifications.
 2. Project design drawings.
 3. Short-circuit and coordination study.
 4. Manufacturer's instruction manuals applicable to each particular apparatus.
 5. Project list of equipment to be inspected and tested as stated above.

PART 2 - SHORT-CIRCUIT AND COORDINATION STUDY

2.1 SHORT-CIRCUIT STUDY

The electrical equipment manufacturer shall perform a short-circuit analysis of the specified new work, and the portions of the existing normal and emergency system that this project touches, of the electrical power distribution system in BHC Building. This analysis shall include:

- A. Calculation of the maximum RMS symmetrical three-phase short-circuit current available at significant locations in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short-circuit currents shall be calculated with the aid of a digital computer. Appropriate motor short-circuit contribution shall be included in the calculation.
- B. The study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
- C. The study shall be calculated from the service entrance to the building, to the lowest overcurrent device or equipment on the electrical distribution system of the panel that was touched under this project. The utility conductors shall not be used for calculations.
- D. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer.
- E. Provide five copies of the short-circuit analysis for the engineer's approval within 60 days of contract award.
- F. A computer printout of input data, a computer printout of calculated results and an explanation of how to interpret the printouts.
- G. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
- H. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X/R ratio of the fault current.
- I. A table of equipment short-circuit ratings versus calculated short-circuit current values.
- J. The short circuit and coordination study shall be completed and forwarded for review within 120 days after award of the contract.

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- K. At the time of the final inspection and tests, all connections at the panels and all splices, etc., must have been completed. All fuses must be in place and the circuits continuous from service switches to all receptacles, outlets, motors, etc.
- L. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner. Where approved by the Engineer.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

The electrical equipment manufacturer shall perform a protective device time-current coordination analysis of the specified electrical power distribution system, and the existing distribution system that was touched under this project. This analysis shall include:

- A. A determination of settings or ratings for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance. The time-current coordination analysis shall be performed with the aid of a digital computer.
- B. An evaluation to the degree of system protection and service continuity possible with overcurrent devices supplied.
- C. Provide five copies of the protective device time-current coordination analysis for the Engineer's approval.
- D. Log-Log plots of time-current characteristic curves.
- E. A tabulation of the suggested settings of the adjustable overcurrent protective devices supplied.
- F. The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the setting or ratings of the overcurrent protective devices supplied.
- G. The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
- H. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner, where approved by the Engineer.

2.3 ARC FLASH HAZARD ANALYSIS

- A. Provide with the coordination and short circuit studies an Arc Flash study and device by device listing of PPE requirements and ratings as required by the NEC and NFPA 70E. All equipment shall have appropriate labeling installed in the field by the electrical contractor as determined by the study.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchgear, switchboards, panelboards, busway, etc.) where work could be performed on energized parts.

PART 3 - INSPECTION AND TEST PROCEDURES

3.1 PROCEDURE

- A. Testing firm to provide and comply with the following:
 - 1. Acceptance test procedures for each individual equipment listed in Part 1 of this section for Engineer review and approval prior to any test and after thorough evaluation of the system. Testing shall conform to the latest version of InterNational Electrical Testing Association (NETA) specifications and standards for electrical power distribution equipment and systems and manufacturer's instructions.
 - 2. Refer to each individual specification section for testing requirements and comply.
 - 3. Inspect installed equipment, record results and report any discrepancy and deficiency with contract documents and governing codes prior to testing. All results shall be submitted to the Engineer for approval.

3.2 SYSTEM FUNCTION TESTS

- A. General:
 - 1. Perform system function tests upon completion of equipment component tests as define in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
 - 2. Implementation:
 - a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
 - b. Test all interlock devices, and trip settings on breakers.
 - c. Record the operation of alarms and indicating devices.

3.3 DEFICIENCIES

- A. All deficiencies reported by testing firm to be corrected by Contractor and Acceptance Test to be re-done accordingly.

END OF SECTION

SECTION 26 05 05

MANUFACTURERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The following lists of manufacturers are for the specifications as identified.
- B. All submittals and documentation shall be in accordance with the project General Requirements, Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".
- C. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed herein. All manufacturers not listed shall be pre-approved prior to bid in order to be considered. Refer to Division 1 for pre-approval format.

TITLE	SPECIFICATION SECTION	MANUFACTURER
Electrical Identification	26 05 53	Ideal Industries, Inc. National Band and Tag Co. Panduit Corp. Seton Name Plate Co. W.H. Brady, Co.
Raceways		
Conduit & Tubing	26 05 33	Alflex Div.; Southwire Co. Allied Div.; Atkore Carlson, Inc. Liquatite Div.; Electri-Flex Wheatland Tube Co.
Conduit Bodies	26 05 33	Appleton Div.; Emerson Electric Crouse-Hinds Div.; Eaton Killark Div.; Hubbell Inc. OZ/Gedney Div.; Emerson Electric Steel City Div.; Thomas & Betts

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TITLE	SPECIFICATION SECTION	MANUFACTURER
Wireway & Enclosures	26 05 33	B-Line Div.; Eaton Hammond Mfg. Hoffman Div.; Pentair Square D Div.; Schneider Electric
Surface Raceways	26 05 33	Hubbell Inc. Isoduct Div; Legrand Square D Div.; Schneider Electric Wiremold Div.; Legrand
Wire and Cables	26 05 19	General Cable Okonite Co. Prysmian Southwire Co.
Electrical Boxes & Fittings		
Raintight outlet boxes	26 05 34	Appleton Div.; Emerson Electric OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Steel City Div.; Thomas & Betts
Bushings, knockout closures and locknuts	26 05 34	Appleton Div.; Emerson Electric Midwest Electric OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Thomas & Betts
Supporting Devices		
Slotted metal Angle & U-channel Systems	26 05 29	American Electric B-Line Div.; Eaton Unistrut Div.; Atkore
Conduit Sealing Bushings	26 05 29	OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Thomas & Betts
Motor, Disconnects and Fuses		
Circuit and Motor Disconnect	26 28 16	Cutler-Hammer Div.; Eaton General Electric Company Siemens (I-T-E-) Square D Div.; Schneider Electric
Fuses (See Note)	26 28 16	Bussmann Div.; Eaton (Basis of Design) Mersen
Connections	26 28 16	Appleton Div.; Emerson Electric Burdny Corp. Ideal Industries, Inc. Thomas & Betts
NOTE:Contractor shall submit fuse coordination for the entire electrical distribution if alternate manufacturer is used.		

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TITLE	SPECIFICATION SECTION	MANUFACTURER
Grounding	26 05 26	Burndy Electrical Cadweld Div.; Erico Ideal Industries Okonite
Automatic Transfer Switches	26 36 23	ASCO

PART 3 - EXECUTION - Not Used.

END OF SECTION

SECTION 26 05 06

BASIC MATERIAL AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Work included in this section consists of conduits, wires and other miscellaneous materials not specifically mentioned in other sections of Division 26, but necessary or required for equipment or system operation or function, and the labor to install them.

1.3 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: Refer to Section 26 05 05.

2.2 CONDUIT RACEWAYS: Refer to Section 26 05 33.

2.3 WIRES AND CABLES: Refer to Section 26 05 19.

2.4 OUTLET BOXES, JUNCTION AND PULL BOXES

- A. Outlet Boxes: Hot-dipped galvanized or sherardized of required size, 4" square minimum, for flush mounted devices and lighting fixtures. Cast-type FD with gasketed covers for surface-mounted devices.
- B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from sheet steel, sized according to code, with screw-on covers, galvanized where required for outdoor exposure.
- C. All exterior boxes shall be cast, gasketed, weatherproof type with cast covers.
- D. Refer to Section 26 05 34 for additional requirements.

2.5 WIRE CONNECTORS

- A. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600 volt, for building wiring and 1000 volt in signs or fixtures.

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- B. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

2.6 CONDUIT HANGERS

- A. Galvanized steel with special accessories for purpose and adequate to support load imposed. Support individual conduit 1-1/2-inch and larger and all multiple conduit runs with hangers. Clamp conduits individually to each support.
- B. Refer to Section 26 05 29 for additional requirements.

2.7 FUSES: Refer to Section 26 28 16.

2.8 ACCESS PANELS

- A. Electrical Contractor to provide access panels for electrical equipment which are required for accessibility by code.

2.9 CONDUIT SLEEVES

- A. Sleeves for Conduit Penetration: Pipe Shields, Inc., model WFB at walls and QDFB at floors. Refer to Division 7 "Firestopping" for additional requirements.

2.10 EQUIPMENT MOUNTING AND SUPPORT HARDWARE

- A. Steel channels, bolts and washers, used for mounting or support of electrical equipment shall be galvanized typed. Where installed in corrosive atmosphere, stainless steel type hardware shall be used.
- B. Refer to Section 26 05 29 for additional requirements.

2.11 PREFABRICATED CURBS

- A. General: Except where curbs are provided with equipment, provide prefabricated curbs for all roof mounted equipment and conduit.
- B. Manufacturers:
 - 1. Design Basis: Pace
 - 2. Other Acceptable Manufacturers:
 - a. Thycurb
- C. Coordinate with roofing Contractor. Exterior insulation, cants, flashing and counter flashing shall be furnished and installed under roofing work, Division 7.
- D. Model: As required.
- E. Roof Curbs
 - 1. Roof curbs shall have a minimum height of 6" or as specified on the drawings, whichever is greater.

2.12 EQUIPMENT SUPPORTS

- A. Provide housekeeping pads for all floor mounted equipment.

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1. Housekeeping pads shall have a minimum height of 4" or as specified on the drawings, whichever is greater.
2. Provide pins to tie new pad to existing floor.
3. Provide rebar within new pad to support equipment load and prevent cracking of pad.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide complete raceway systems for all conductors including control wiring and low voltage wiring unless otherwise noted.
- B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.
- C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.

3.2 RACEWAY: Refer to Section 26 05 33.

3.3 JUNCTION PULL BOXES

- A. Construct junction or pull boxes not over 150 cubic inches in size shall be standard outlet boxes, and those over 150 cubic inches shall be constructed the same as "Cabinets," with screw covers of same gauge metal. Removal covers must be accessible at all times.
- B. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.

END OF SECTION

SECTION 26 05 09

ELECTRICAL DEMOLITION AND RELOCATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Requirements of the following Divisions and Sections apply to this Section:
 - 1. Division 26 Section 26 05 02 "Electrical Requirements."
 - 2. Division 9 Section "Painting" for related requirements.
- C. Refer to other Division 26 Sections for additional specific electrical demolition or relocation associated with specific items.

1.2 SUMMARY

- A. This Section includes basic requirements for demolition and relocation of electrical materials, equipment, and installations. The Contractor shall be responsible for visiting the site prior to bid to determine the actual conditions, which might affect the bid or contract price. No allowance will be made subsequently resulting from the neglect to visit the site and make such determinations.
- B. Generally, electrical items that are to be replaced with other equipment in the same location is work covered by this section. Also covered by this section are electrical items that are to be removed in their entirety or that are to be relocated to another place.

1.3 UTILITY SERVICES

- A. Maintain existing utility services. Where necessary to cut existing conduits, wires, cables, etc. of utility services or fire protection systems, they shall be cut and capped at suitable places or where directed by the Owner's representative.
- B. Electrical service in demolition area shall be reduced to a minimum and identified to eliminate uncertainty about which circuits are energized.
- C. The Contractor shall notify the Owner's representative in writing of any planned utility interruptions including interruptions of power to communications and fire protection systems at least two weeks in advance or as otherwise specified. The request shall state the reason, date, beginning time, and expected duration of such interruptions. No interruptions shall be made without the Owner's written concurrence and such interruptions shall be coordinated with the Owner to cause the least inconvenience to the Owner's operations. Service interruptions which cannot wait for written approval may be granted with verbal approval from the Owner's representative. After verbal approval is granted, written confirmation shall be issued by the Contractor as soon as practical.

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- D. The contractor for construction, excavation and demolition operations at or near existing underground utilities shall use Industrial Code 53 of Title 12, Rules and Regulations of the State of New York to verify and/or relocate existing utilities in the area of the proposed new utility service. The telephone number to contact Code 53 in N.Y. State is 1-800-245-2828.

1.4 PROTECTIVE MEASURES

- A. Provide the following protective measures:
 - 1. Wherever existing roofing surfaces are penetrated by electrical conduit, they shall be protected against water infiltration. Water leaks shall be repaired immediately upon discovery when they occur.
 - 2. Temporary protection against damage for all portions of existing structures and grounds where work is to be done, materials handled, and equipment moved or relocated.
- B. The Contractor shall be responsible for contacting utilities or locating services and obtaining locations of all underground services in the general area of demolition work.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. The Contractor shall provide all equipment and materials necessary for the removal or relocation of electrical equipment.
- B. Materials used in restoration or repairing work related to demolition and relocation shall conform in type, quality, and function to that of the original existing construction or as otherwise indicated.

2.2 DISPOSAL AND RETENTION

- A. Materials and equipment resulting from work and removed from the building or structures, or parts thereof, shall become the property of the Contractor and shall be removed from the site by the Contractor except as follow:
- B. Items removed or noted to be retained by the Owner but which are declined to be retained by the Owner shall be removed from the site by the Contractor.
- C. Combustible waste material and rubbish shall not be stored or allowed to accumulate within a building or its vicinity, but shall be kept in a suitable trash container for subsequent removal or shall be removed from the premises as rapidly as practical.

PART 3 - EXECUTION

3.1 GENERAL

- A. Disconnect, remove and/or relocate electrical material, equipment, devices, components, and other work noted and required by demolition or alterations in existing construction.
- B. Where the drawings indicate that equipment is to be replaced or where other equipment requires the relocation of existing equipment, the existing equipment shall be removed or relocated as though it was specifically noted to be removed or relocated.

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- C. Provide new material and equipment required for relocated equipment.
- D. Wherever electrical materials have been removed from surfaces of the building or structure, those surfaces shall be patched and repaired.
- E. Remove, cut, alter, replace, patch, and repair existing work as necessary to install new work. Unless otherwise indicated or specified, do not cut, alter, or remove any structural members, ducts, piping, or service lines without approval of the Owner's representative.
- F. Existing work or equipment to be altered or extended and found to be defective shall be reported to the Owner's representative before it is disturbed or any further work is performed on it.
- G. Where electrical equipment is indicated to be removed or relocated, the work shall include the complete disconnection from its source, dismantling as necessary, and removal or installation of all conduit, wires, cables, etc. Unless noted otherwise, wires shall be removed from conduits back to the last utilization device or to the panelboard. No wiring shall be removed that prevents operation of other equipment not scheduled or indicated to be removed.
- H. Perform and schedule all demolition work with other trades and work of the contract as necessary for the efficient progress and flow of the work.
- I. Remove conductors from existing raceways to be rewired. Clean raceways as required prior to rewiring.
- J. Tape both ends of abandoned conductors, and cap outlets and abandoned raceways.
- K. Cut and cap abandoned floor raceways flush with concrete floor or behind walls and ceilings.
- L. Dispose of removed raceways and wiring.
- M. Where any fixture or wiring device is removed, provide adequate size and type of blank plates over each outlet.
- N. Dispose of removed electrical equipment as directed.
- N. All electrical work in adjoining areas which is indicated on the Drawings to continue to function but is affected by demolition work shall be reconnected and restored to present function as part of the electrical system of the Buildings.
- O. Connect new work to existing work in a neat and acceptable manner, with minimum interference to existing facilities.
- P. Maintain continuous operation of existing facilities affected by the work.
- Q. Alarm and emergency systems are to be interrupted only with the written consent of the Owner.
- R. Temporary shutdowns when required, to be made only with written consent of Owner at times not to interfere with normal operations.
- S. Where indicated on the Drawings or required by the alteration scheme, the Contractor shall

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remove all electrical outlets, switches, and other devices, complete with associated wiring, conduit, etc., from partitions, walls, and floors that are to be removed. When the removal of these makes dead electrical wiring that is to remain, Contractor shall install junction boxes or other devices necessary to make the circuits affected continuous and ready for operation. Otherwise, wiring shall be removed back to the nearest electrical outlet box that is to remain, or to the panelboard.

- T. All raceways which become exposed beyond finished surfaces because of the alteration work shall be removed and rerouted behind finished surfaces.
- U. Wiring that is to be removed as a result of demolition work, but is required to continue to function, shall be interrupted at convenient locations, rerouted (new wiring and conduits) and reconnected for continuation of their original function. New wiring extensions shall match existing ones in all respects, conductor ampacity, conduit size, etc.

END OF SECTION

SECTION 26 05 10

PROJECT CLOSEOUT

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:
 - 1. Copies of all warranties
 - 2. Operation & Maintenance Manuals
 - 3. Required tests
 - 4. Certifications
 - 5. Record drawings
 - 6. Permit requirements

- B. The contractor shall compile a closeout manual which shall include:
 - 1. A list of all required tests and a place for signoff of date completed.
 - 2. A list of all submittals with dates of acceptance by the engineer.
 - 3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
 - 4. Test procedures to be used for life safety systems.
 - 5. Project close out check list.

- C. The final closeout manual shall include the following:
 - 1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
 - 2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
 - 3. Copies of all warranties..

- D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

- A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:
 - 1. A list of all required tests.
 - 2. Preliminary schedule showing major milestones for completion of the electrical and technology systems.

- B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.

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- C. Within 2 weeks of substantial completion submit a completed "Project Closeout Check List", and the Final Closeout Manual.
- D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary - Electrical

- The following tests have been completed. Submit test report for record.
 - Feeder Testing and Reporting (Megger Result)
 - Grounding System Testing and Reporting
 - ATS and Diesel Generator Testing and Reporting
- All main components of the electrical system cleaned and vacuumed. This includes unit substations, switchboards, distribution boards, panel boards, etc. Provide M-E Engineers with schedule when this is going to occur and a letter stating it has been completed.
- The contractor shall schedule a walk through with the engineer to inspect all main feeder sizes. Covers for panel boards and distribution boards should be removed by the contractor for visual inspection of feeder sizes.
- Provide spare fuses and fuse cabinets ((1) in each switch gear room) per specifications.
- Panelboard directories completed.
- Record drawings submitted.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

- A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 LIFE SAFETY SYSTEMS

- A. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official.
- B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.
- C. Once tested by the contractor and fully operation the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

3.3 COORDINATION WITH OTHERS

- A. The Division 26 contractor shall coordinate his requirements with the general contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 26, 27 and 28 systems.

3.4 PUNCH LISTS

- A. The contractor shall submit in writing that the project is ready for final review by the engineer.
- B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.
- C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.
- D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION

SECTION 26 05 19

WIRES AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Requirement of the following Division 26 Sections apply to this section:
 - 1. Electrical Requirements

1.2 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Division 2 Section "Earthwork" for trenching and backfilling.
 - 2. Division 26 Section "Electrical Boxes and Fittings" for connectors for terminating cables in boxes and other electrical enclosures.
- C. The work includes providing wire and cable complete with all accessories in accordance with Drawings and Specifications and as required for a complete system. Wiring size referenced in this Section shall be AWG, except as noted. For special wiring for individual systems refer to respective Section of these Specifications.

1.3 SUBMITTALS

- A. Product Data for electrical wires, cables and connectors.
- B. Shop drawings shall include detail drawings and data sheets for all wire and cable, compression wire connectors, large aluminum wire connectors, and large copper wire connectors.
- C. Cable Pulling Submittals:
 - 1. The following requirements pertain to all 600 volt or less feeders, sized 4/0 AWG or larger that are either in excess of 200 feet or requiring more than 180° of bend:
 - 2. The Contractor shall utilize a pulling calculation software package, such as Polywater Cable Management Software or SKM Cable Pulling Analysis Software, to model and determine the expected pulling tensions and sidewall pressures that the conductor(s) will be exposed to. If the calculations determine that the expected pulling tensions and sidewall pressures will exceed the manufacturer's recommended values, the contractor is responsible making modifications necessary to correct the problem and re-run the analysis. Contractor shall submit the results of the analysis for the intended conduit routing prior to commencement of cable pulling for engineer's approval. If the intended conduit routing is modified due to engineers comments or coordination with the other trades the contractor must re-run the analysis and resubmit for approval.

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3. Contractor to submit detail conduit routing drawings showing pulling set ups and direction of cable pulls. These drawings shall clearly detail the intent of the cable pulls with reference to cable pull models. Indicate all splice locations for approval by engineer and owner.
4. Submit wire manufacture's maximum pulling tension and sidewall pressure recommendation.
5. Submit cable pulling machine for approval.
6. Submit UL listed pulling lubricants for approval.
7. Utilize Tensiometer similar or equal to, Condux Running Line Tensiometer, CableGlider HD.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code:
- B. NFPA 70 "National Electrical Code."
 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
 2. Comply with most restrictive code.
- C. UL Compliance: Provide components, which are listed and labeled by UL under the following standards.
 1. UL Std. 44 Rubber Insulated Wires and Cables
 2. UL Std. 83 Thermoplastic-Insulated Wires and Cables
 3. UL Std. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 4. UL Std. 854 Service Entrance Cable
- D. NEMA/ICEA Compliance: Provide components which comply with ANSI/NEMA WC 70-2009 / ICEA S-95-658-2009.
- E. IEEE Compliance: Provide components, which comply with the following standard.
 1. Std. 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

F. QUALITY ASSURANCE

1. "Manufacturers" - Firms regularly engaged in manufacture of wire and cable of types and ratings whose products have been in satisfactory use in similar service for not less than 5 years.
2. Provide wire and cable which has been listed and labeled by Underwriters' Laboratories, and comply with applicable portions of National Electrical Manufacturers Association Standards.
3. Provide wire and cable produced by a manufacturer listed as an Approved Manufacturer in this section.
4. Provide equipment whose performance under specified conditions, is certified by the Manufacturer.

PART 2 - PRODUCTS

2.1 WIRES AND CABLES (600 VOLT COPPER CONDUCTORS – BASE DESIGN)

- A. General: Provide suitable wire and cable for the temperature, conditions and location where installed. All wires and cables shall be new and delivered to the site in unbroken packages and reels.
- B. All wires and cables shall be of the same manufacturer throughout the entire project.
- C. Conductors:
 - 1. Provide solid conductors for power and lighting circuits #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.
 - 2. Minimum conductor size shall be No. 12 for lighting and power and No. 14 for control and alarm. Increase wire as noted hereinafter for long runs.
 - 3. Communications and signal wiring shall conform to the recommendations of the manufacturer's communication and signal systems and shall be as specified in respective Sections of these Specifications.
- D. Conductor Material: All wires and cables shall be copper, single conductor rated at 600 volts, which conform to or exceed ICEA specifications. Use XHHW-2 or THWN-2/THHN, UNO.
 - 1. Emergency system feeders shall either be a listed 2-hour cable paired with listed conduit, MI cable, or encased in minimum of 2 inches of concrete.
- E. Grounding conductors: Shall be of the same type as its associated phase conductors.
- F. All conductors shall be label with wire size, insulation rating, etc using an engraved process. Computer scan or labels are not permitted.
- G. Color Coding for phase identification in accordance with Table 1 in Part 3 herein.
 - 1. Where color-coded cable is not available, certify in writing and request permission for overlap color taping conductors (minimum length 6 in.) in accessible locations.
 - 2. Conductors for control circuits and signal systems shall also be consistently color coded to avoid confusion and permit easy identification of conductors. The IPCEA color code shall be used wherever possible. No two wires in the same raceway shall be the same color, unless provided with flameproof linen identification tags on each end.
- H. Connectors for Conductors:
 - 1. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
 - 2. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600 volt, for building wiring and 1000 volt in signs or fixtures.
 - 3. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.
- I. Splices and Taps:
 - 1. No. 10 AWG and smaller - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.

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2. No. 8 AWG and larger - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90-degree, 600-volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage, and temperature and shall not have an insulation value less than the conductors being joined.

J. Wire Sizes

1. For General Use:
 - a. No. 12 minimum copper wire shall be used for lighting and power.
 - b. No. 10 minimum copper wire shall be used at 120 volts and over 90 ft. for 15 amp circuit and 60 ft. for 20 amp circuit length.
 - c. No. 10 minimum copper wire shall be used at 265 volts and over 175 ft. circuit length.
2. For Control and Alarm (unless otherwise noted):
 - a. No. 14 minimum copper wire shall be used.
 - b. No. 12 minimum copper wire shall be used at 120 volts and over 60 ft. circuit length.
3. For Other Voltages and Phases and for Longer Circuit Lengths:
Size wire as required to maintain equivalent voltage drop.
4. Raceways: Increase raceway sizes for larger wire as required.

K. Insulation:

1. Rubber and thermoplastic insulation shall comply with ASTM and IPCEA standards. Paper and lead insulation shall comply with AEIC standards

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Use the following wiring methods as indicated:
 1. Install all wire in raceway. Power and control wiring shall be installed in separate raceways.

3.2 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and connectors in compliance with NEC.
- B. Coordinate cable and wire installation with other Work.
- C. Wire and cable shall not be drawn into conduit and raceways until all conduit work is complete - joints made up tightly and the entire run secured in place.
- D. Do not install more conductors in a raceway than indicated on the drawings. A maximum of six branch circuits are to be installed in any one conduit on a 3-phase, 4-wire system, unless specifically noted otherwise on the drawings. When more than three branch circuits are installed in a raceway, the conductor size shall be increase per code for derating.

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- E. Minimum wire size shall be a No.12 AWG except for control or signal circuits, which may be No. 14 AWG.
- F. Unless otherwise indicated on drawings, all wiring for branch circuits shall be a minimum No. 12 AWG in $\frac{3}{4}$ " conduit, protected by 20 amperes circuit breakers.
- G. Size of current carrying conductors, unless noted otherwise on drawings, shall be determined from Table 310-16 of the latest National Electric Code for the load served.
- H. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.
- I. Care shall be exercised in pulling to avoid damage to the wire or cable. Lubricants shall be used for pulling wire or cable if the character of the pull would otherwise damage the conductors, insulation or jacket. Pull no thermoplastic wires at temperatures lower than 0EC.
- J. Use pulling means including: fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.
- K. Size of conduits, unless specifically shown, shall be determined from Appendix C of the latest National Electrical Code (whichever is more stringent).
- L. Keep conductor splice to minimum. All splices shall be made within junction boxes, wiring troughs and other enclosures as permitted by the NYC Code or National Electrical Code (whichever is more stringent). Do not splice conductors in panelboards, safety switches, switchboard motor control centers or motor control enclosures. Splices in conductors installed below grade will not be permitted, unless approved in writing by the Architect.
- M. Install splice and tap connectors, which possess equivalent or better mechanical strength and insulation than conductors being spliced.
- N. Use splice and tap connectors which are compatible with conductor material.
- O. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- P. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers' torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque values specified in UL 486A and UL 486B.
- Q. 600 Volt Wire and Cable:
 - 1. The inside of conduits and raceways shall be dry and clean before wires are pulled.
 - 2. Cables shall be supported at the upper end of all risers and at intermediate points as required by the NYC Code or NEC (whichever is more stringent). Supports shall be O.Z. Type "R" or approved equal, insulation wedges or Kellems grips.
 - 3. Wire and cable shall be installed in accordance with manufacturer's instructions.
 - 4. Seal, between the wire and conduit with a non hardening compound approved for the purpose, all cable and wire entering a building from underground where cable exits the conduit.

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5. Cable spacers shall be installed where required. Spacers shall be conduit fittings for spacing of cables at terminations and shall consist of galvanized or cadmium plates, steel or malleable iron threaded conduit and fittings and inserts of non-metallic insulating material with openings adequate to accommodate cables being spaced. Cable spacers shall be adequate to accommodate cables being spaced. Cable spacers shall be O.Z. Mfg. Co., Inc. Type E or Type EL with grounding lug or approved equal.
6. Provide separate raceways for conductors of 120/208 and 277/480 volt systems.
7. Install cable limiters at each end of each conductor of more than three (3) paralleled conductors per phase, over 100 ft. in length. Limiters shall be rated 600 volts, 200,000 amps RMS interrupting capacity and shall have waterproof sleeves.
8. Direct burial cables shall be covered with a 1 in. thick by 8 in. wide white-pine board pressure-treated with a non-creasote-type wood preservative, placed over 3 in. layer of clean, well-tamped sand.
9. Under all paving and at crossover of all other utilities, underground cables shall be installed in PVC conduit and encased in concrete.
10. Thermoplastic wires shall not be installed in computer area raised floors.
11. Provide individual raceways for two pole ungrounded circuits.
12. In certain systems, equipment furnished by an approved manufacturer may require a different number and arrangement of conductors from that indicated on the Drawings. In such cases, the Contractor for the work under this Division shall comply with such requirements at no additional cost to the Owner.
13. In the event the Contractor for the work under this Division or Section chooses to furnish and install a system or item of equipment of different arrangement from that shown or specified, he shall furnish and install any additional wiring and conduit required by the system at no additional cost to the Owner.
14. In wireways and large pull boxes, lace and tie off conductors in groups of 3 phases and neutral (if used) to limit conductor unbalanced loading. Conductor group shall be as installed in conduits.
15. Tag all feeders and risers in all pull boxes and in all gutter spaces through which they pass. Tags shall be engraved white core nameplates identifying feeders as shown on the Drawings or the circuit protective device from which they originate.
16. Leave all wires with sufficient slack at terminal ends for convenient connections and fixtures and for convenient servicing. Stow loose ends neatly in outlet box.
17. Splices and taps shall be made in accessible boxes, panelboards fittings, gutters, terminal panels, etc. only. Materials shall be compatible with the conductors, insulations and protective jackets on the cables and wires.
18. All copper conductors No. 8 & larger shall be spliced, and tapped with color-keyed compression connectors, as manufactured by Thomas & Betts Co., Series 54000, Ideal Industries Series 87000, or approved equal. The manufacturers recommended tooling shall be used. Mechanical type connectors shall not be used. All copper conductors No. 8 and larger shall be terminated with self crimping, self adjusting, spring action type cable terminators, as manufactured by CYTOLOK or approved.
19. All copper conductors No. 10 AWG & smaller shall be terminated and spliced with Ideal Industries wing-nut wire connectors, or approved equal compression connectors. The nylon self-insulated type shall be used to isolate the terminal from other metal parts and equipment.
20. Splices and joints shall be insulated with materials approved for the particular use, location, voltage, and temperature. Insulation shall be not less than that of the conductors being joined.
21. Plastic electrical insulating tape shall be flame retardant, cold and weather resistant.
22. All circuit and control wiring in cabinets, panels, pullboxes, and junction boxes shall be tied and held with nylon Ty-Rap cable ties as manufactured by Thomas & Betts Co. or approved equal.
23. Wire identification ties fastened to conductors at the point of attachment to terminal

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blocks and equipment components shall be nylon, self-locking Ty-Raps as manufactured by Thomas & Betts Co., Series Ty-51M, 53M, or approved equal.

24. Cables shall be tagged in all pull boxes, wireways and wiring gutters of panels. Where two or more circuits run to or through a control device, outlet box or junction box, each circuit shall be tagged as a guide in making connections.
25. Tags for feeders shall indicate feeder number, size, phase, voltage, origin and termination. Feeder tags shall identify all phases individually.
26. Tags for control and alarm wiring shall indicate type of control or alarm, size of wire and origin and termination.
27. Tags shall be Thomas Betts Co., Ideal Industries wire-marker dispenser type, self-laminated wire markers.
28. Wire lubricating compound shall be suitable for the wire insulation and conduit with which it is used, and shall not harden or become adhesive. Lubricating compound shall be Ideal Industries, Type Yellow 77, or approved equal. Lubricating compound shall not be used on wire for isolated type electrical power systems.
29. Contractor shall examine the areas and conditions under which wire and cable are to be installed, and notify Architect in wiring of conditions detrimental to proper and timely completion of the work.
30. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.
- B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. Prior to completion of project, an infrared scan of switchgear and panelboard feeder equipment connection shall be performed when all loads are energized.
- E. TABLE 1: Color Coding for Phase Identification:

1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

<u>208V/120 Volts</u>	<u>Phase</u>	<u>480V/277 Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

3.4 FEEDER TESTING

- A. Products
 1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the test described in this section.

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B. Execution

1. Visual and Mechanical Inspection
 - a. Inspect cables for physical damage and proper connection in accordance with one-line diagrams.
 - b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
 - c. Check cable color coding with Table I in this section and National Electrical Code standards.
2. Electrical Tests
 - a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
 - b. Perform continuity test to insure proper cable connection.
 - c. Megger conductors phase-to-phase and phase-to-ground for continuity and insulation tests before connection to utilization devices for the following:
 1. 100 percent of feeders.
 2. 10 percent of branch circuits.
 3. 100 percent of 3-phase motor branch circuits.
 - d. Verify phase rotation for all three-phase motor circuits.
3. Test Values
 - a. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.
 - b. Submit results to Engineer for approval in accordance with Section 26 05 02 and 26 05 03.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work of this section.
- C. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

1.2 SUMMARY

- A. Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
- B. Type of electrical grounding and bonding work specified in this section includes the following:
 - 1. Solidly grounded.
- C. Applications of electrical grounding and bonding work in this section includes the following:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Building frames - structural steel.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.
- D. Refer to other Division-26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.
- B. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding

connections.

- C. Submit ground riser diagram for entire project. Show bus bars with transformer ground electrode conductors, etc.
- D. Shop drawings shall include splice kits, ground rods, and ground wire.

1.4 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 10 years.
- B. **Installer's Qualifications:** Firms with at least 5 years of successful installation experience on projects with electrical grounding work similar to that required for project.
- C. **Codes and Standards:**
 - 1. **Electrical Code Compliance:** Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
 - 2. **UL Compliance:** Comply with applicable requirements of UL Standards No.'s 467, "Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
 - 3. **IEEE Compliance:** Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
 - 4. For patient care area electrical power systems, grounding shall conform to Article 517 of the NEC.

PART 2 - PRODUCTS

2.1 GENERAL

- A. **Materials and Components:**
 - 1. Provide electrical grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2.2 CONDUCTORS

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- A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductors, 1/3 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 5 AWG, stranded conductors.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
- D. Grounding Bus: Rectangular bars of annealed copper (1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by Cadweld (or approved equal) manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper clad steel; not less than 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.
- C. Ground clamps shall be bronze, solderless type with bronze screws suitable for receiving required or noted conductors.
- D. Grounding wires shall be UL and NEC approved types, copper, with insulation color identified green, except where otherwise shown on the Drawings, or specified.

PART 3 – EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No.10 AWG and smaller, and stranded conductors for No.8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned copper conductor, No.3/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by

manufacturer of splicing and termination kits.

- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No.3/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. The conduit shall not be acceptable as an equipment ground.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
- C. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 EXAMINATION

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.5 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. General: Install electrical grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 - 1. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
 - 2. Where required to obtain the specified ground resistance, install multiple rods.
 - 3. Where rock prevents the driving of vertical ground rods, install grounding electrodes in horizontal trenches to achieve the specified resistance.

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- D. Test Wells: Ground rod driven through drilled hole in bottom of manholes. Manholes are specified in Division 26 Section "Underground Services and Manholes," and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
- Bond the water piping to the building ground with approved grounding clamps. All ground connections shall be executed with the same thorough workmanship as the connections for normal current carrying parts. The work must be neatly installed, as careless grounding either in appearance or workmanship will be rejected.
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment each unit substation, or each main electrical room grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. 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 torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- I. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
- J. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

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- K. The complete electrical installation shall be permanently and effectively grounded before the water meter and grounded in accordance with all code requirements, whether or not such connections are specifically shown or specified. Measured resistance to ground shall be 5 ohms. maximum.
- L. Parts of the electrical installation to be grounded shall include, but not be limited to, the following: underground distribution, outdoor substation service equipment, electrical service system neutral, conduit system for light and power, switchgear housings, cabinets, housings and neutrals of transformers, motor frames, housings of alarm and control panels and associated devices, emergency distribution system, communications, and other non-current carrying metal parts of electrical equipment.
- M. All copper bars for grounding shall be medium hard drawn. After installation, the copper bar shall be painted with one coat of an approved lacquer.
- N. Ground conductors shall be of sizes and material in accordance with the requirements of the National Electrical Code. Cable for grounding connections shall be bare in accordance with the latest revisions of ASTM Designations B3 and B8. All open bare grounding cable shall be secured in place with cast and honed malleable clamps and clamp backs, and 1/4 inch bolts.
- O. Ground wires shall be continuous without splices. There shall be no soldered joints in any ground connection. Connectors, clamps, etc. shall be solderless type.
- P. Ground outdoor electrical equipment to driven ground rods, as required by code.
- Q. Ground interrupted metallic raceways with ground conductors connected to metallic raceway at each end.
- R. For hospitals and Health Care Facilities, provide all grounding in accordance with Article 517 of National Electrical Code (NFPA 70) and as further described in these Specifications.
- S. Service at power company interface points shall comply with the power company ground resistance requirements.
- T. For duct banks and manholes provide a bare equipment grounding conductor in each duct bank containing medium or high voltage cables. Connect the grounding conductor to the switchgear ground bus, to all the manhole hardware, to the cable shielding of medium or high voltage cable splices and terminations, and equipment enclosures.

3.6 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.
- B. Inspect all connections prior to concealing same.

PART 4 – APPROVED MANUFACTURERS

- A. For ground rods.
 - 1. Carolina Galvanizing.
 - 2. Weaver Electric

END OF SECTION

SECTION 26 05 29

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related Sections: The following Sections contain requirements that related to this Section:
 - 1. Refer to Division 26 Sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.
- D. Engineered Design consisting of details and engineering analysis for supports for the following items:
 - 1. Conduit (racked)
 - 2. Ceiling mounted boxes
 - 3. Conduit - Ceiling mounted, concrete encased.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with local codes as well as NFPA 70 "National Electrical Code."
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up

services.

- C. Installation shall comply with local authorities seismic requirements.

PART 2 - PRODUCTS

2.1 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.3 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with local codes and NEC requirements.

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- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with local codes, the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼-inch diameter or larger threaded steel. Use spring fasteners that are specifically designed for supporting single conduits or tubing.
 - 6. Space supports for raceway in accordance with NEC.
 - 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, supports at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 - 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors (i.e., strain reliefs).
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and wall for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Stopping" requirement of Division 7.
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control

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components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions or light steel construction, use sheet metal screws.
 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
- J. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
1. Expansion anchors.
 2. Toggle bolts.

Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

NOTES:

1. Maximum spacing of supports (feet).
2. Maximum spacing for IMC applies to straight runs only. Otherwise the maximum of EMT applies.
3. Support for cable tray shall be as directed in their respective sections.

END OF SECTION

SECTION 26 05 33

RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
 - 1. Rigid metallic conduit (RMC).
 - 2. Intermediate metal conduit (IMC).
 - 3. Electrical metallic tubing (EMT).
 - 4. Rigid non-metallic conduit (PVC).
 - 5. Wireway (WW).
- B. Related Sections: The following section contains requirements that relate to this section:
 - 1. Division 26 Section "Electrical Boxes and Fittings" for conduit connectors, fittings, and couplings.
 - 2. Division 7 Section "Firestopping" for conduit penetrations through rated walls and slabs.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of contract and Division 1 Specification Section.
- B. Product Data for the following products:
 - 1. Raceways and fittings.
 - 2. Wireways and fittings.
 - 3. Boxes and fittings.
- C. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL.
- D. Manufacturers - Firm regularly engaged in manufacture of raceways of types and capacities required and whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1
 - 1. Shall be full weight steel pipe, hot dip galvanized inside and outside, threaded, minimum 3/4 inch.
 - 2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.
- B. Intermediate Steel Conduit: UL 1242.
 - 1. Shall be intermediate weight steel pipe, hot dip galvanized, threaded, minimum 3/4 inch.
 - 2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.
- C. Electrical Metallic Tubing and Fittings: ANSI C80.3.
 - 1. Shall be thin wall steel pipe, galvanized, thread-less, minimum 3/4 inch. EMT shall not be used for cable rated above 600 volts.

2.2 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit Fittings: NEMA TC 3; match to conduit type and material.
 - 1. Shall be self-extinguishing, UL listed.
 - 2. Located in building interiors and direct burial, shall be heavy wall, Schedule 40.
- C. Conduit and Duct Accessories: Types, sizes and materials complying with manufacturer's published product information. Mate and match accessories with raceway.

2.3 CONDUIT BODIES AND FITTINGS

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- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
 - 1. Metallic conduit fittings shall be corrosion resistant.
- C. EMT Conduit Bodies: **Use bodies with steel set screw connectors** and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
 - 1. Material shall be steel or malleable iron only.
 - 2. Couplings and connectors shall be "concrete tight" or "raintight", couplings and connectors for conduit sizes 2-inch and smaller shall be of the gland and ring compression type. Connectors shall have insulated throats.
 - 3. **Set screw** or indent type **connectors are not permitted**. Compression waterproof connection type fittings only shall be utilized.
- D. Nonmetallic Conduit: Use nonmetallic conduit bodies conforming to UL514B.
- E. Liquid-Tight Flexible Conduit Fittings: With threaded grounding cone, a steel, nylon or equal plastic compression ring, and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without O-ring seal. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.
- F. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit and IMC – and EMT, larger than ¾" size.
 - 1. Bushings shall be of the metallic insulated type.
- G. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25' or less, and the long type in runs 26' to 80'. The long type shall be a two piece barrel and piston joint, providing 6" of the total movement range in ¾" through 6" conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2" of total movement range in ¾" to 2" conduit sizes.
 - 1. Shall comply with UL 467 and UL 514 and shall accommodate, 0.75 inch deflection, expansion, or contraction in any direction, and shall allow 30 degree angular deflections.
 - 2. Shall include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC tables for ground conductors.
 - 3. Shall be watertight, seismically qualified, corrosion- resistant, threaded for and compatible with rigid or intermediate metal conduit.
 - 4. Jacket shall be flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
- H. Seal Off Fittings: Threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

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- I. For weatherproof and dust-tight installations provide liquid-tight fittings with sealing ring and insulated throat.
- J. Rigid steel and IMC conduit fittings:
 - 1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be steel or malleable iron only.
 - 2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
 - 3. Bushings shall be of the metallic insulating type, and shall consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - 4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type. In concealed work, each fitting shall be installed in a flush steel box with blank coverplate having the same finish as that of other electrical plates in the room.
- K. Direct burial plastic conduit fittings shall be as recommended by the conduit manufacturer.
- L. Surface metal raceway fittings shall be as recommended by the raceway manufacturer

2.4 WIREWAYS

- A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC. Wireways shall be steel and of sizes noted and shall have a minimum of No. 16 gauge thickness.
- B. Wireway covers shall be hinged type.

2.5 CONDUIT SUPPORTS:

- A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.
- B. Individual conduit hangers shall be designed for the purpose, with pre-assembled closure bolt and nut, and provisions for receiving hanger rod.
- C. Multiple conduit (trapeze) hangers shall be of not less than 1-1/2 by 1-1/2 inch, 12 gage steel, cold formed, lipped channels. Hanger rods shall be not less than 3/8-inch diameter steel.
- D. Solid masonry and concrete anchors shall be a type approved for the purpose.

2.6 SLEEVES

- A. Provide and assume responsibility for locating and maintaining in proper position all sleeves required for the work.
- B. For raceways in sleeves, provide seals of oakum packing and lead or O.Z. Type WSK series compound on both sides.

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- C. For cables through sleeves, provide seals similar to O.Z. Type WSCS compound.
- D. Through floors, exterior masonry walls, roof, and underground, sleeves shall be schedule 40 galvanized steel pipe. For area not requiring schedule 40 pipe, sleeves shall be 18 gauge galvanized steel pipe.

2.7 CONCRETE MARKERS

- A. Provide over all underground raceway bends and terminations, cylindrical concrete columns markers. The markers shall be 5 in. diameter and 18 in. deep and shall have imbedded marked bronze plate noting the direction of the raceway.

2.8 FIRE SEALANTS

- A. Openings through floors and walls in which cables, conduits, or pipe pass shall be sealed by U.L. classified smoke and fire stop fittings, and have an hourly rating equal to the fire rating of the floor or wall. Fittings shall be similar to O-Z Gedney Type "CES" or "CAFS".
- B. Penetrations through fire-rated floors in which wiring for floor service outlets are routed shall be sealed by U.L. classified smoke and fire-stop fittings, and shall have an hourly rating equal to the floor rating. Fittings shall be similar to O-Z Gedney Type "PTFS".

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Use the following wiring methods:

USES	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
	Rigid Metallic Conduit (RMC)	Interm. Metal Conduit (IMC)	Elec Metal Tubing (EMT)	Flex metal Conduit (FMC)	Liquid Tight Flex Metal Conduit (LFMC)	Rigid Alum. (RA)	Metal Clad Cable (MC)	Rigid Non Metal (PVC)	Wire-Way (WW)	Surface Metal Raceways (SMR)
Outdoor underground concrete encased, below building or away from building	X							X		
Outdoor above ground exposed or concealed	X	X								
Outdoor above ground final connection to vibrating equip: xfrms, solenoids, motors, etc.					X					
Indoor 600 volts and above concrete encased.	X									

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USES	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
	Rigid Metallic Conduit (RMC)	Interm. Metal Conduit (IMC)	Elec Metal Tubing (EMT)	Flex metal Conduit (FMC)	Liquid Tight Flex Metal Conduit (LFMC)	Rigid Alum. (RA)	Metal Clad Cable (MC)	Rigid Non Metal (PVC)	Wire-Way (WW)	Surface Metal Raceways (SMR)
Indoor exposed 10 feet to floor in "back of house" spaces such as mechanical, electrical, basements, attics, etc.	X	X								
Indoor exposed above 10 feet to floor.			X							
Indoor concealed homerun to panelboards, and for branch circuits			X							
Indoor concealed final branch wiring to receptacles and light fixture. Max 50' length from homerun j-box to outlet. MC not allowed for isolated ground circuits, or homeruns to panels, or connections to mechanical equipment. Max conductor is #8 AWG MC Cable.										
Indoor final connection to vibrating equipment: xfrms, solenoids, motors, etc. in dry areas										
Indoor final connection to vibrating equipment: xfrms, solenoids, motors, etc., in moist, humid,										

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USES	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
	Rigid Metallic Conduit (RMC)	Interm. Metal Conduit (IMC)	Elec Metal Tubing (EMT)	Flex metal Conduit (FMC)	Liquid Tight Flex Metal Conduit (LFMC)	Rigid Alum. (RA)	Metal Clad Cable (MC)	Rigid Non Metal (PVC)	Wire-Way (WW)	Surface Metal Raceways (SMR)
wet, or corrosive areas.										
Within concrete slabs, or connections to cast-in-place floor boxes. LFMC not allowed for homerun. Maximum sizes and locations of conduit subject to approval by structural engineer and Architect	X	X								
Hazardous Areas	X									
Terrazzo floor with conduit routed underneath, not within terrazzo.	X									
Fire Alarm initiating circuits and signaling circuits.			X							
Fire alarm system auto dialer telephone circuit	X									

- B. In health care facilities, wiring of emergency systems shall be mechanically protected per NEC 517.30(C)(3). Flexible raceways are not permitted except as allowed in the exceptions of the referenced code section.

3.2 INSTALLATION

- A. General: Install electrical raceways in accordance with manufacturers' written installation instructions, applicable requirements of NEC, and as follows.
- B. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

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- C. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
- D. Complete installation of electrical raceways before starting installation of conductors within raceways.
- E. Provide supports for raceways as specified elsewhere in Division 26 and in accordance with NEC and local authorities seismic requirements.
- F. Prevent foreign matter from entering raceways by using temporary closure protection.
- G. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells.
- H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
- K. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.
- L. All exposed conduits in public areas shall first be approved to be routed in public areas, then be painted to match surrounding walls. Verify exact color with the Architect.
- M. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.
- O. Tighten set screws of threadless fittings with suitable tool.
- P. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with concave side against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.

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- Q. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.
- S. Telephone and Signal System Raceways: In addition to the above requirements, raceways 2-inches and smaller, shall have a maximum length of 150 feet with a maximum of two 90° bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
- T. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed 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:
 - 1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
 - 2. Where required by the NEC.
- U. Stub-up Connections: 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. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
- V. Flexible connection: Use length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement. Install separate equipment grounding conductor across flexible connections.
- W. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- X. All underground conduits shall be installed a minimum of 48 inches below finish grade for primary medium voltage feeders and 30 inches for 480 volt feeders. All other conduits shall be installed in accordance with the NEC and coordinated depth with other trades.
- Y. Grounding: Install a separate green equipment grounding conductor in all raceways from the panelboard/junction box supplying the raceway to the receptacle or equipment ground terminals. Conduits will not be permitted as a ground conductor.

3.3 RACEWAYS

- A. Install conduit and tubing products as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation", and in accordance with the recognized industry practices to ensure that products serve intended function.
- B. Run raceways concealed, except as noted. Exposed raceways shall be run parallel with or at right angles to walls.

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- C. Raceways supports shall be provided by means of ceiling trapeze, strap hangers, or wall brackets, structural steel angles or channels. Provide U-bolts at each floor level or riser raceways and connected to acceptable supports. Secure raceways to supports with pipe straps or U-bolts. Spacing of support shall be as per NEC and per manufacturer's recommendations.
- D. Mount supports to structure with toggle bolts on hollow masonry, expansion shields or inserts on concrete and brick, machine screws on metal, wood screws on wood. Nails, rawl plugs or wood plugs are not permitted.
- E. Provide a 12 in. minimum separation between raceways and steam and hot water pipes. Provide approved thermal insulation for electric lines where this separation cannot be maintained.
- F. Keep raceways clear of motor foundations and from underside of boilers. Also, install raceway so that they will not obstruct headroom, doorways, or walkways.
- G. For outlets located in hung ceilings, run raceways in hung ceilings and support from structure above. For lay-in ceilings, install conduits high enough to permit removal of ceiling tiles.
- H. In walls, run raceways vertically only.
- I. Mechanically join all metal raceways, enclosures and junction boxes to form a continuous electrical conductor. Connect all electrical boxes, fittings and cabinets so as to provide effective electrical continuity and firm mechanical assembly. Maintain grounding continuity of interrupted metallic raceways with ground conductor.
- J. Install complete conduit runs before pulling in wire or cable. Install raceways so that required conductors may be drawn in without injury or excessive strain to raceway or cable. Where raceway size is not indicated, follow applicable code.
- K. Do not cross pipe shafts or ventilation duct openings with raceway. Route raceway to avoid present or future openings in floor, wall or ceiling construction, when so indicated on the drawings.
- L. Keep end of raceways plugged or capped during construction.
- M. For empty raceways over 10 ft. long, provide fish or pull wire. Pull wire shall consist of steel core nylon rope and terminal ball.
- N. Concrete encased conduits run exposed inside the building shall have Class I concrete encasement. They shall be marked (stenciled) 10 ft. on centers, including in hung ceiling, with the notations, "Danger, High Voltage".
- O. Damaged or deformed raceway is not permitted and shall be removed.
- P. Branch circuit conduits shall not be supported by the suspended ceiling or its supporting members, lighting fixtures, mechanical piping, or air-conditioning ducts.
- Q. Conduits located underground beyond the building shall be concrete encased and shall be installed as follows:
 - 1. With a minimum of 30 in. top cover, above the conduits, and sloped away from the building.

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2. Placed over well-tamped trench bottom and on concrete blocks 5 ft. on center. Conduits shall be anchored to prevent their movement. Conduit joints shall be staggered a minimum of 6 in. apart. All joints shall be watertight.
 3. With a minimum separation between the electric and low voltage conduits of 12 in., if fiber only, or 24 in. if any copper is used present or future, of well tamped earth or concrete.
 4. With entry into manholes through end bells.
- R. For conduits and direct burial cable entering the building, and for the manholes preceding the conduits entry to the building, perform the following:
1. Plug all empty raceways.
 2. Enter through floor or wall entrance fittings. The entrance fittings shall have a gland assembly which shall be capable of providing a seal around the conduit or cable to withstand 50 foot head of water without leakage. For greater than 50 foot head, the sealing assembly shall be similar to O-Z Gedney Type "FSK" or "FSCS".
- S. Work with extreme care near existing ducts, conduits, cables and other utilities to avoid damaging them.
- T. Galvanized Rigid steel conduit:
1. Paint male threads of field threaded conduit with graphite base pipe compound.
- U. Intermediate metal conduit:
1. Paint male threads of field threaded conduit with graphite base pipe compounds.
- V. Electric metallic tubing (EMT):
1. EMT is permitted to be used with the following limitations: for branch circuits only, and in dry locations (hung ceilings, hollow block walls and furred spaces).
- W. Polyvinyl chloride conduit (PVC):
1. Cut ends square, ream smooth, wipe clean, apply approved solvent cement and quarter turn as drawing up tight.
 2. Convert to steel conduit using adaptors when entering the building from underground locations.
 3. Maintain a 3 ft. minimum clearance of PVC conduits from hot water and steam lines.
- X. Provide expansion-deflection fittings at expansion joints and on length of runs in accordance with manufacturer's recommendations. Expansion-deflection fittings shall be of size as required complete with bonding jumper.
- Y. For Hazardous Locations:
1. UL approved sealing fittings shall be installed, to prevent passage of explosive vapors as required by the NEC.
- Z. For Wet, Damp, or Moist Locations:

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1. Provide sealing fittings, to prevent passage of water vapor, where conduits pass from warm to cold locations, much as refrigerated spaces, air conditioned spaces, or similar spaces.

3.4 SLEEVES

- A. Sleeves shall be provided in accordance with the following guidelines:
 1. Set required sleeves and inserts in place during progress of construction to avoid cutting of completed work.
 2. Provide sleeves for raceway passing through floors and foundations. Determine exact location of sleeves in field to avoid interference with structural members or equipment of all trades.
 3. Install sleeves rigidly so that proper position and alignment will be maintained during construction and pouring of concrete.

3.5 FIRE STOPS

- A. Where wiring, conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, or floors, install an approved fire-stop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight and shall completely fill clearances between raceways and openings.
- B. Floor, exterior wall, and roof seals shall also be made watertight.

3.6 ADJUSTING AND CLEANING

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

3.7 FIELD QUALITY CONTROL

- A. Contractor shall perform continuity tests by testing the resistance of all feeder conduits from the service to the point of their final distribution using 1 conductor return. The maximum resistance shall be 25 ohms.

END OF SECTION

SECTION 26 05 34

ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. This section is a Division 26 Basic Electrical Material and Methods section, and is a part of each Division 26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

- A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.
- B. Types of electrical boxes and fittings specified in this section include the following:
 - 1. Outlet boxes.
 - 2. Junction boxes.
 - 3. Pull boxes.
 - 4. Bushings.
 - 5. Locknuts.
 - 6. Knockout closures.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five years.
- B. Installer's Qualifications: Firms with at least five years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.
- C. Local Code and NEC Compliance: Comply with local code and NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- D. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.
- F. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical boxes and fittings.

- B. Shop Drawings: Submit layout drawings of electrical floor, junction and pull boxes showing accurately scaled box layouts and their spatial relationship to associated equipment.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Outlet boxes for concealed work shall be galvanized steel, 4 in. square or octagon (except as otherwise required by construction, devices or wiring) and as follows:
 - 1. Above ceiling: 1-1/2 in. deep.
 - 2. In ceiling or slab: 3 in. deep.
 - 3. In wall for fixtures: 2-3/4 in. deep.
 - 4. In wall for receptacles and switches: 2-1/2 in. deep.
 - 5. With raised covers and fixture studs where required.
 - 6. Through-the-wall type are not permitted.
- B. Outlet boxes for exposed work shall be galvanized cast iron or aluminum with threaded hubs. Except as otherwise required by construction, devices or wiring the outlet boxes shall be in 4 in. round x 2 in. deep for mounting on ceilings and 4 in. square x 2 in. deep for mounting on walls.
- C. Outlet boxes without fixture or device, shall have blank cover.
- D. Extension rings shall be provided as required to suit various conditions.
- E. Grounding screw and cable wiring connector shall be provided as required by wiring method.
- F. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides.
- G. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.
- H. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- I. Outlet boxes located outdoors and damp locations shall be weatherproof corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.

2.2 JUNCTION AND PULL BOXES

- A. Junction and pull boxes shall be made of galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match flush mounted panelboard trim.

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- B. Provide junction and/or pull boxes as noted or as required. All junction and pull boxes shall be accessible.
- C. Junction and pull boxes located outdoors and in damp locations shall be galvanized cast iron with threaded hubs and gaskets.
- D. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Box dimensions shall be 30"W x 48"L x 36"D. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.
- E. Provide barriers in junction boxes or pull boxes between:
 - 1. 277/480 volt wiring energized from separate services.
 - 2. 120/208 volt and 277/480 volt wiring.
 - 3. Emergency and normal wiring.

2.3 BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS

- A. Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of local codes, NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- C. Provide raintight "in use" outlets for interior and exterior locations exposed to weather or moisture.
- D. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- E. Boxes separated by less than 24 inches shall be provided with firestop putty pads on the backside of all boxes exceeding 16 sq. inches in area. Provide Firestop putty pads on the back side for all outlet boxes within 24 inches of each other, in opposite sides, and at same elevation, in the same wall. Provide Firestop putty pads on the back side for all boxes in a wall or ceiling where the aggregate surface area of the outlet boxes exceeds 100 sq. inches per 100 sf of surface of wall or ceiling area. Firestop putty pads shall be Hilti CP617XI (9" x 9") for each box 16 sq inches or less.
- F. Position recessed outlet boxes accurately to allow for surface finish thickness.

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- G. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.
- H. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.
- I. Provide electrical connections for installed boxes.
- J. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
- K. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.
- L. Subsequent to installation of boxes, protect boxes from construction debris and damage.
- M. Set boxes square and true with the building finish. Boxes shall be secured to the building structure by adjustable strap irons.
- N. Verify outlet locations in finished spaces with Architectural Drawings of interior details and finishes. Take caution in locating outlet to allow for overhead pipes, ducts, and variations in arrangement, thickness in finish, window trim and other Architectural Construction Details.
- O. Correct any inaccuracy in locating outlets without additional expense to the Owner. Refer to Architect any condition that would place an outlet box in an unsuitable location, such as a molding, break glass in wall finish, or behind radiator.
- P. Mount outlet boxes for similar equipment at uniform height within same or similar areas. Where mounting height or location of outlets is not shown or specified, mount outlet as best suited for equipment connected thereto, or as directed.
- Q. Close all unused openings in outlet boxes with knockout closers manufactured for this purpose. Provide blank plates on outlet boxes in which no device is installed or device installed does not provide a suitable cover.
- R. Provide barriers between switches connected to different phases for voltages exceeding 150 volts to ground.
- S. Outlet boxes for fixtures recessed in hung ceilings, shall be accessible through the opening created by the removal of the fixture.
- T. Securely fasten exposed outlet boxes by attaching to permanent inserts or lead anchors with machine screws. Adequately support all boxes during construction to prevent movement.
- U. Boxes for concealed work shall be pressed steel galvanized and shall conform to UL's "Standard for Outlet Boxes and Fittings." Outlet boxes shall be provided with a galvanized steel cover or extension ring depth as required.

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- V. All ceiling fixture outlet boxes, except as noted, shall be 4" octagonal and 1-5/8" deep and with 3/8" fixture stud. Where cast in slab, boxes shall be open back concrete type.
- W. Wall bracket outlets shall be 4" square and 1-5/8" deep with cover having 2-7/8" round openings and except for lampholders shall be furnished with fixture stud.
- X. Junction outlets shall be the same as bracket outlets but without stud, furnished with covers to suit each condition and as directed. Where number of conductors exceed capacity of standard box, provide special size box.
- Y. All outlet boxes for concealed convenience receptacles or local switches shall be 4" square and 1-5/8" deep with regular deep switch extension cover, except where installed on columns they shall be of sufficient depth so that conduits may be installed into these boxes in back of fireproofing. Outlet boxes for gang receptacles and switches shall suit space conditions.
- Z. Boxes for use with surface mounted raceways shall be of the same construction and manufacture as the raceway.
- AA. Boxes shall be of the cast type for switches and receptacles when installed on the exterior of the project. Such boxes shall be aluminum or malleable iron of the threaded hub type, with covers without projecting edges or corners and with openings suitable for the devices to be contained therein. Outlet boxes and covers shall be galvanized or anodized and shall be gasketed.
- BB. Except where special outlets are required, wall outlets for signaling systems shall be 4" square with single gang raised cover and bushed plate.
- CC. Panel, junction and pull boxes:
 - 1. Panel, junction and pull boxes shall be located clear of other trades equipment, accessible, supported from the building structure, and independent of the conduits.
 - 2. Conceal junction and pull boxes in finished spaces.
 - 3. Coordinate size of motor terminal boxes with motor branch circuit conduit and wiring.

3.2 GROUNDING

- A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION

SECTION 26 05 43

UNDERGROUND SERVICE AND MANHOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Materials and Methods, Sections of Division 26.
- C. Excavating, backfilling and Compacting and Division 3, concrete.
- D. All excavation is unclassified.
- E. Definitions:
 - 1. Engineer: Soils Engineer employed by Owner and empowered to undertake necessary inspections and approvals.
 - 2. Unclassified excavation: Excavate and grade all materials that can be removed without drilling or blasting.

1.2 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for all underground feeders and manholes as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of all other trades.
- C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

1.3 SUBMITTALS

- A. Product data for the following: Electrical Manholes, Duct Spacers.
- B. Test reports as required for compaction and concrete work in Division 2 and 3.

1.4 QUALITY ASSURANCE

- A. Compaction density test: ASTM D1557.
- B. Owner will hire an independent soils laboratory to conduct in place moisture-density tests to insure that all work complies with this specification.
 - 1. Notify Construction Manager or Owner's representative at least 2 weeks prior to anticipated date of testing.

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2. Contractor will pay additional cost if work is delayed due to his failure to notify Owner's agent as specified above.
- C. Comply with all aspects of "Safety Rules & Regulations for Excavation: as promulgated by the state in which excavation will occur.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store conduit to avoid warping or deterioration.
- B. Store plastic conduit on flat surface protected from direct rays of sun.

PART 2 - PRODUCTS

2.1 DUCT SYSTEM

- A. Duct System: Multiple and single, conduits.
 1. Separators: Plastic or other non-metallic, non-decaying material.
- B. Pull Wire: No. 9 galvanized iron, or heavy nylon cord, free of kinks and splices.

2.2 MANHOLES

- A. Electric Manholes: Types as indicated:
 1. Cover and frame: 36" diameter, gray cast iron with machine finished seat for perfect joint between cover and frame.
 2. Provide floor drain with grate.
 3. Provide cable racks, ladder rungs, 2 ground rods, cable pulling iron.
 4. Provide manholes with 3500 psi, single pour concrete with reinforcement. Manholes shall have a minimum size of that noted on the Drawings. Increase the depth of the manholes to accommodate the raceway entry plus 2 ft. Provide sump pit in every manhole.
 5. Locate raceway entries at right angles to and near end of the walls of the manhole. Seal openings watertight and paint exterior with 2 coats of asphaltic compound. Clear interior prior to energizing cables.
 6. Frames and covers shall be heavy duty, cast iron, approximately 75 lbs., with machined bearing surfaces. Covers shall be solid, with indented top, and with inscription of identification as approved by the Engineer.
 7. Windows for duct bank terminations shall be provided and shall be filled with concrete after duct placement.
 8. Manhole shall have pulling eye irons located on the walls opposite the raceway entries. Pulling eye irons shall be imbedded in the concrete and fastened to the reinforcing rods.
 9. All hardware provided in the manhole shall be hot dipped galvanized.
 10. Double manholes shall include a 3 in. drain pipe at the floor between compartments.
- B. Cable Racks: Galvanized, mounted on wall.
 1. Equipment with minimum of 8 adjustable hooks; minimum 2 spare hooks on each rack.
 2. Insulators: Best quality, high glazed porcelain; provide for each hook.

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3. Space racks so each end of splices are supported horizontally.
4. Manhole shall be provided with cable racks. The rack supports shall consist of channels, approximately 2 ft. on center, similar to Globe Co. NO. G-3812.

C. Ladder Rungs: Galvanized, 12" x 12" x 3/4" diameter.

1. Set with 7" clearance from rung to wall.
2. Ladder rungs shall be imbedded in the concrete and fastened to the reinforcing rods. The ladder rungs shall be located directly under the manhole cover, and they should clear all raceway entries.

D. Ground Rods: 3/4" x 10' long, copper weld.

2.3 HANDHOLES

- A. Provide heavy weight traffic handholes with 3500 psi, single pour concrete. Handholes shall have a minimum size of that noted on the Drawings. Handholes shall be provided complete with lifting ring or lifting eye, ribbed non-skid top surface and 4" high letters on cover spelling "ELEC" for power and "TELE" for size.
- B. Handhole cover shall consist of a bolted 3/8 in. checkered steel plate with neoprene gasket.
- C. Seal openings watertight and paint exterior with two coats of asphaltic compound.

2.4 WARNING TAPE

- A. Provide plastic ribbon designed for direct burial in earth; yellow background with black warning letters.

PART 3 - EXECUTION

3.1 INSTALLATION OF MANHOLES

- A. Determine exact location of each manhole after careful consideration has been given to location of other utilities, grading, and paving.
 1. Do not begin construction until location of each manhole has been approved by Architect/Engineer.
- B. Construct manholes of type indicated in accord with applicable details.
 1. Mix, place and cure concrete or set precast unit on non-expansive soil bed in accord with Division 3 requirements.
- C. Set frames and cover:
 1. Paint exterior with 2 coats asphaltic paint after inspection and approval by Architect/Engineer, and before setting.
 2. In paved areas, set top of manhole covers flush with finished surface of paving.
 3. In unpaved areas, set top of manhole covers approximately 1/2" above finished grade.
 4. Where final grades are higher than top of manhole, install sufficient number of courses of grade rings between top of manhole and manhole frame to elevate manhole cover to final

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grade level.

- D. The manhole chimney shall consist of a sufficient number of brick and mortar courses between top of manhole and manhole frame to reach the required level. The manhole frame shall be grouted to the chimney.
- E. Frames and covers in roadways and paved areas shall be traffic type. In unpaved areas, frames and covers may be nontraffic type.
- F. Install cable racks, ladder rungs and cable pulling iron.
- G. Drive 2 ground rods into earth not less than 9' before manhole floor is placed.
 - 1. Extend ground rods approximately 4" above manhole floor.
 - 2. Drive a ground rod into the earth, before the floor is poured, at a convenient point close to the manhole wall. Ground rods shall protrude approximately four inches above the manhole floor.
 - 3. Install ground wires around the inside perimeter of the manhole and anchor them to the walls. Connect the wires to the ground rods by the exothermic welding process to form solid metal joints, and bond the ground wires to the exposed non-current carrying metal parts of racks, etc., in the manholes. Also bond the wires to duct bank bare equipment grounding conductors.

3.2 DUCT BANK

- A. Form all duct banks in square or rectangular fashion as shown, and place concrete so that voids around ducts are filled.
- B. Provide minimum concrete thickness between duct of 2 inches.
- C. Adjust final slopes on-site to coordinate with utilities and structure.
- D. Install drain assembly with saddle cutouts for each conduit. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with ½ inch stainless steel straps to conduit assembly to prevent mechanical displacement. Connect to (piping drain) washed gravel sump 36 inch square by 36 inches deep.
- E. Install on undisturbed soil where possible. Use pit run gravel and sand, placed in 8 inch lifts and compacted for backfill.
- F. After installation, clean and swab ducts.
- G. Install galvanized steel pullwires in spare ducts. Cap empty ducts with screw covers.
- H. Label conduit at stub-up and manhole penetrations in accordance with Section 26 05 53.

3.3 DUCT LINE

- A. Duct lines shall be in accordance with the NEC, as shown on the drawings, and as herein specified.
- B. Ducts shall be sloped to drain towards manholes and handholds, and away from building and equipment entrances. Pitch shall be not less than four inches in 100 feet. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 50 feet in the horizontal

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and vertical directions. The use of manufactured bends is limited to building entrances and stub-ups to equipment.

- C. Underground conduit stub-ups to equipment inside of buildings shall be galvanized rigid steel, and shall extend a minimum of 10 feet clear of foundations. Stub-ups to equipment, mounted on outdoor concrete slabs, shall be galvanized rigid steel, and shall extend a minimum of five feet away from edge of slab. Install insulated grounding bushings on the terminations. Steel conduits shall be coupled to the ducts with suitable adapters, and the whole encased with three inches of concrete.
- D. Upon completion of the duct bank installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter 1/2-inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.
- E. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable nonhardening compound to prevent the entrance of moisture and gases.
- F. Install concrete encased ducts for both high and low voltage systems, unless otherwise shown on the drawings.
- G. Duct lines shall consist of single or multiple duct assemblies encased in concrete installed with top of duct bank not less than 30 inches below established grade. Ducts shall be uniform in size and material throughout the installation, unless otherwise shown or specified.
- H. Rigid, unplasticized, polyvinyl chloride spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of three inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed five feet.
- I. Provide plastic spaces to maintain the following clearances between individual ducts:
 - 1. For like services: Not less than three inches.
 - 2. For power and signal services: Not less than 24 inches.
- J. Couple the ducts with proper couplings. Couplings shall be staggered in rows and layers to insure maximum strength and rigidity of the duct bank.
- K. Within five feet of building and manhole and handhold wall penetrations, install reinforcing steel bars within the top and bottom of each concrete envelope to provide protection against vertical shearing. Where shown on the drawings, incorporate steel reinforcing in the duct envelopes.
- L. Ducts shall be kept clean of earth, sand, or gravel during construction, and sealed with tapered plugs upon completion of each portion of the work.
- M. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, handholes, ducts, conduits and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to insure smooth durable transitions.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
 - 1. Buried electrical line warnings.
 - 2. Identification labeling for raceways, cables, and conductors.
 - 3. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.
- B. Related Sections: The following Sections contain requirements that relate to this Section;
 - 1. Division 9 Section "Painting" for related identification requirements.
 - 2. Division 26 Section "Wires and Cables" for requirements for color coding of conductors for phase identification.
- C. Refer to other Division 26 Sections for additional specific electrical identification associated with specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Schedule of identification nomenclature to be used for identification signs and labels.
- D. Samples of engraved, plastic laminate to be used on switchgear, switchboards, disconnect switches and panelboards.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the identification of Piping Systems," with regard to type and size of lettering for raceway and cable

labels.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mil thick by 1 inch to 2 inches in width.
- B. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic tape with magnetic tracer strip not less than 6 inches wide by 4 mil thick. Printed legend indicative of general type of underground line below.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wrap around, cable/conductor markers with preprinted numbers and letters.
- D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for sign up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal power and red letters on white face for emergency power. Plastic laminate shall be punched for mechanical fasteners.
- E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide ¼-inch grommets in corners for mounting.
- G. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- H. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of local codes and the NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.2 CONDUIT IDENTIFICATION

- A. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange

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background. Install on outside of box cover. Also label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels at concealed boxes.

- B. Underground Electrical Line Identification: During trench backfilling, for underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines, installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct-buried and in raceway.
- D. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:
 - 1. Fire Alarm Systems: Red.
 - 2. Fire Suppression Supervisory and Control System: Red and Yellow.
 - 3. Mechanical and Electrical Supervisory System: Green and Blue.
 - 4. Telephone System: Green and Yellow.
 - 5. Tag or label conductors as follows:
 - a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and intent.
 - b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure label each conductor or cable. Provide label on each box indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 - c. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facilities' electrical installations.
- E. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- F. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

<u>208/120 Volts</u>	<u>Phase</u>	<u>480/277 Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

- G. Use conductors with color factory-applied the entire length of the conductors except as follows:

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1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Apply colored, pressure-sensitive plastic tap in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
2. All grounded conductors No. 6 AWG and smaller shall be a factory applied color across the entire length of conductors.

H. Power Circuit Identification:

1. Securely fasten wrap-around marker bands to cables, feeders, and power circuits in pull boxes, junction boxes, and switchgear rooms.

I. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, or instruction signs where required by NEC where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

J. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit for electrical equipment including central or master unit of each electrical system. This includes communication/signal/alarm system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 3/8-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), black lettering in white field for normal power and red lettering on white field for emergency power. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Motor starters, motor control centers.
 - e. Pushbutton stations.
 - f. Power transfer equipment.
 - g. Contactors.
 - h. Remote-controlled switches.
 - i. Dimmers.
 - j. Control devices.
 - k. Transformers.
 - l. Power generating units.
 - m. Telephone switching equipment.

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- n. Fire alarm master station or control panel.
 - o. Lighting control panel.
 - p. Multi-outlet raceways shall have each outlet labeled with panelboard and circuit number.
- K. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification (including room numbers) of items controlled by each individual breaker.
- L. Electrical Service Room Distribution Placard: In each of the main electrical rooms, provide a single line riser diagram placard of the entire electrical distribution fed from that room. The placard shall also identify where other services are located per NEC 230.2(e). The riser diagram shall be framed under glass and mounted on the wall in the electrical room. The print shall be of diffusion transfer process to eliminate fading.
- M. Arc Flash Warning Signs: Provide arc flash warning signs at all panelboards, switchboards, control panels, meter enclosures, starters, motor control centers, transfer switches, etc., that may be subject to inspection or repair. Warning signs shall be white letters on a red background with informative text in black on a white background. Signs shall be permanently affixed directly to the equipment in a readily visible location or located adjacent to the equipment with a smaller warning label on the equipment that directs maintenance personnel to the more informative sign. Warning sign data shall be appropriate and specific to each piece of equipment or device and shall identify flash hazard category, incident energy, VAC shock hazard, flash protection boundary, limited approach boundary, restricted approach boundary, restricted approach boundary, and prohibited approach boundary. Warning sign shall also indicate all recommended protective equipment. Calculations supporting the data on each warning sign shall be completed by a licensed professional engineer hired by the Contractor and presented to the owner in book form for future reference. Arc flash warning signs shall be in accordance to the most stringent of NFPA 70E, NFPA 70, and OSHA.

END OF SECTION

SECTION 26 08 00

COMMISSIONING GENERATOR AND ATS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the Owner, automatic transfer switch as shown on the drawings and hereinafter specified.
- B. The generator is existing and the new transfer switch will connect to the existing generator and control the generator operation.
- C. Equipment and wiring shall be provided and installed by Electrical Contractor under this contract.

1.3 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer

1.4 QUALITY ASSURANCE

- A. Installer's Qualifications: Firms with at least 5 years successful installation experience on projects utilizing transfer switches and generators similar to those required for this project.
- B. All work shall be performed in accordance with all rules, regulations, and all applicable codes.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store equipment in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.
- B. Handle equipment carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation, wiring, and commissioning within owners pre-arranged time frame.

PART 2 - PRODUCTS

2.1 LOAD BANKS: Refer to Section 26 05 05.

2.2 WIRES AND CABLES: Refer to Section 26 05 19.

PART 3 - EXECUTION

3.1 SCOPE OF WORK

- A. The following work shall be performed by the Contractor, Generator representative, and ATS representative.

COMMISSIONING

After the complete installation of the ATS, and tie in to the existing generator power and control, the individual equipment shall be tested as stand-alone, then followed by testing of the complete system as a whole. This process is divided into two parts. Part one, Static proof of the equipment, and part two, dynamic proof of the system. Throughout these two parts, all vendors and contractors shall simultaneously perform their roles.

Provide temporary load bank for testing/commissioning

Signatures are required by each vendor and contractor for both the static and dynamic parts of the testing. All static testing check lists shall be filled out and signed and the dynamic testing sectioned shall be signed by all.

PART 1 – STATIC EQUIPMENT TESTING

Generator

Generator

- Inspections to be performed by factory authorized personnel only
- Technician Name (print)_____
- Owner or Owner's Representative Name (print)_____
- Genset Nameplate Data
- Model # _____
- Engine Serial # (found on engine block)_____
- Fuel Type Diesel
- RPM

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- HZ
- Utility Service kW _____ kVA _____
- Volts _____ Phase _____
- Do the generator set load conductors correctly connect to the circuit breakers and/or the emergency side of the transfer switch? _____
- Verify that the engine is filled with oil, the cooling system is filled with coolant/antifreeze and battery(ies) are filled with acid.
- Inspect for proper belt alignment and tension.
- Press the LED test, if equipped on controller. Do all the LEDs on the panel illuminate? _____
- Check the coolant level, add coolant as necessary, and replace the radiator cap. Verify that all hose clamps are tight and secure. Place the generator set engine control switch in the RUN position.
- Verify that all the wire connections from the generator set to the transfer switch and optional accessories are tight and secure.
- Close the generator set main line circuit breakers connected to the transfer switch.
- Place the generator set engine control switch in the RUN position.
- Check the generator set voltage, frequency, and phase sequence on three-phase models. The generator set must match utility source and load.
- Place the generator set engine control switch in the OFF/RESET position.
- Place the transfer switch in the TEST position. NOTE: Obtain permission from the building authority before proceeding. This procedure tests transfer switch operation and connects building load to generator set power.
- Readjust frequency to 60 Hz with total building loads.* Verify no load frequency to be no more than 62.0. Adjust if necessary. (Mechanical governor only)
- Release the transfer switch test switch. The transfer switch should retransfer to the utility source after appropriate time delay(s).
- Allow the generator set to run and shut down automatically after the appropriate cool down time delay(s).
- Set the plant exerciser with load to the customer's required exercise period, if equipped.
- Verify that all options on the transfer switch are adjusted and functional for the customer's requirements. Transfer Switch delay setting: TDES____ TNE____ TDN____ TDEC____
- In phase monitor ON____ OFF____
- Verify that all options on the transfer switch are adjusted and functional for the customer's requirements.
- Factory Technician Signature _____
- I _____ received training on _____

Please print name of person receiving training and have him/her sign his/her name
Date

Notes

Pre-start checks to be made

- To Test system, shutting off utility power is recommended but not always possible. If necessary follow the ATS test procedures to put the system online. Make recordings of load test on warranty validation sheet. Include all meter readings. Watch for proper operation, leaks, etc., and make notes of such.
- When normal power is restored the ATS will timeout, re-transfer to normal, then, in most cases allow for engine cool down before stopping automatically. (Timing functions may vary.)
 - Check existing generator is connected to ATS with both power and control.

Automatic Transfer Switch

Authorized Technician Name _____

ATS No. _____ Priority No. _____ Sub Priority No. _____ Cat. No. _____
_____ Load _____ S.O.No. _____ Location _____

Switch Type: __ ATS __ ATS/ Bypass __ w/ Acc.28 (Overlapping Neutral)

Pre- Operational Checks :

- Visual Inspection: Inspect and verify the following prior to Energizing any power source to the switch.
- Power termination's completed and properly dressed. __ YES __ NO
- Manually operate the ATS using the manual transfer handle to verify that the Barriers have been properly reinstalled. __ATS __ YES __ NO __ Bypass Sw. __ YES __ NO Important Note: If the ATS switch barriers are not properly re-installed, they can cause the switch to bind up during a transfer and cause severe damage to the switch and controls.
- Control termination's completed and properly dressed. __ YES __ NO
- Cabinet has been Cleaned of all construction dust and debris. __ YES __ NO
- Proper clearance has been maintained for maintenance. __ YES __ NO
- All cabinet hardware and mechanical fasteners installed. __ YES __ NO
- Switch Identification Nameplate installed. __ YES __ NO
- Optional- Communications equipment and termination's completed and properly dressed. __ YES __ NO
- Phase rotation: Normal source __ CW __ CCW, Emergency source __ CW __ CCW

Operational Checkout: Normal and Emergency power must be available to verify the following.

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- Status Indications: __ Feat. 9A (ATS connected to Normal) __ YES __ NO
- Feat. 9B (ATS connected to Emergency) __ YES __ NO
- Feat. 9C (Normal Source available) __ YES __ NO
- Feat. 9D (Emergency Source available) __ YES __ NO
- Feat. 5 (Test Switch) __ YES __ NO
- Feat. 6B (Reset to Normal) __ YES __ NO
- Feat. 17 (Area Protection) __ YES __ NO
- Feat. 30B (Load Shed Controls) __ YES __ NO
- Feat. 30BL (ATS Load Shed Active Indication) __ YES __ NO
- ATS/Bypass Status Indications: Optional
- Bypass connected to Normal __ YES __ NO
- Bypass connected to Emergency __ YES __ NO
- Normal Source available __ YES __ NO
- Emergency Source available __ YES __ NO
- ATS connected to Normal __ YES __ NO
- ATS connected to Emergency __ YES __ NO
- ATS Disconnected __ YES __ NO
- ATS in TEST position __ YES __ NO
- ATS Connected __ YES __ NO
- Existing generator control and power is connected YES ____ NO ____

Functional ATS Tests

- ATS Transfer Tests - __ Normal to Emergency
- Emergency to Normal

Functional ATS/Bypass/Isolation switch Tests. The following Bypass Switch transfer tests will be performed with the ATS DISCONNECTED.

- Bypass Switch Transfer Tests - __ Auto to Normal
- Normal to Auto to Emergency
- Emergency to Auto to Normal
- Normal to Auto

The following Automatic Transfer Switch tests will be performed with the ATS in the TEST position.

- ATS Transfer Tests - Normal to Emergency
- Emergency to Normal

The following Automatic Transfer Switch tests will be performed with the ATS in the CONNECTED position.

- ATS Transfer Tests - Normal to Emergency
- Emergency to Normal
- ATS Load Shed Tests - Shed ATS to Normal (No Normal Power available)

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- Bypass ATS to Emergency

The following Automatic Transfer Switch tests will be performed with the ATS in the CONNECTED position.

- Simulate Generator and ATS failures to trigger automatic emails and texts to designated Client, Generator, and ATS personnel.

Punch list Items:

—

—

—

Signature _____ Date _____

SECTION 26 28 16

DISCONNECTS, FUSES AND ENCLOSED BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections, apply to work of this section.

1.2 SUMMARY

- A. Provide all circuit and disconnect switch and circuit breaker work including fusing, electrical connections to electrical equipment as indicated on the drawings and schedules.
- B. Applications of electrical power connections specified in this section include the following:
 - 1. To grounds including earthing connections.
 - 2. To panelboards, distribution boards and similar equipment.
- C. Disconnect switches shall be fabricated by same manufacturer as the existing equipment manufacturer.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on disconnect switches, fuses, equipment connectors.
- B. Fuse Product Data: For each type of fuse indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings:
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Fuse sizes for elevator feeders and elevator disconnect switches, and circuit breakers.

1.4 QUALITY ASSURANCE

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- A. All equipment shall be in compliance with codes and standards referenced in Section 26 05 02 titled "Electrical Requirements".
- B. "Manufacturers" - Firms regularly engaged in manufacture of the type of equipment required for the application, whose products have been in satisfactory use in similar service for not less than 5 years.
- C. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches." Provide circuit and motor disconnect switches which have been UL listed and labeled.
- D. Comply with NEC (NFPA 70) for construction and installation of safety and disconnect switches.
- E. Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," including, but not limited to, tightening of electrical connectors to torque values indicated.
- F. NEMA Compliance: Comply with applicable requirements for NEMA Stds Pub/No. KS 1, "Enclosed Switches," and No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."
- G. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600 Volts or Less."
- H. NEMA Compliance: Comply with NEMA FU1 for cartridge fuses.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than **40 deg F (5 deg C)** or more than **100 deg F (38 deg C)**, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Furnish and install safety switches as required for equipment. Switches shall be of size, number of poles, and fused or non-fused, as required for job conditions and the National Electrical Code.
- B. Switches shall be equipped with fuse contacts and jaws which ensure positive fuse and jaw contact by means of reinforcing spring clips or other approved means. All current carrying parts shall be silver-plated. Hinges shall be non-current carrying. Switches shall be so designed that they can be locked in either open or closed position.
- C. All switches shall have switch blades which are fully visible in the OFF position when the door is open. Switches shall have removable arc suppressors, where necessary to permit easy access to line-side lugs. Lugs shall be UL listed for aluminum and/or copper cables and front removable. 30A thru 100A switches shall have provisions for field installed fuse pullers. Switches shall include solid neutral where required.
- D. All safety switches shall be NEMA 1 enclosed Type "HD" (heavy duty) quick-make, quick-break, and have interlocking cover with handle that may either be front or side operating with padlocking provisions. Provide NEMA 3R weather proof enclosures where indicated on the drawings or exposed to exterior or damp locations. Incorporate rejection clips where used with

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Class "R" fuses.

- E. Handle position shall indicate if switch is ON or OFF. Handle shall have provision for padlock.
- F. Switches shall be rated for voltage, poles, amperes, and horsepower, as required or shown on Drawings. All switches shall be rated for maximum available fault current as required or shown on Drawings.
- G. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated on drawings. See Section "2.3" for Fuse specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- H. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated on drawings.
- I. Accessories:
 - 1. Captive Fuse Pullers: Provide built-in pullers arranged to facilitate fuse removal.

2.2 CONNECTIONS FOR EQUIPMENT

- A. General: For each electrical connection indicated provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wirenuts. All other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings:
 - 1. General: Provide metal conduit, tubing and fitting of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Section 26 05 06 titled "Basic Materials and Methods" and Section 26 05 33 titled "Raceways and Boxes" and in accordance with the following listing of metal conduit, tubing and fittings:
 - a. Rigid steel conduit.
 - b. Rigid metal conduit fittings.
 - c. Electrical metallic tubing.
 - d. EMT fittings.
 - e. Flexible metal conduit.
 - f. Flexible metal conduit fittings.
 - g. Liquid-tight flexible metal conduit.
 - h. Liquid tight flexible metal conduit fittings.
- C. Wires, Cables, and Connectors:
 - 1. General: Provide wires, cables and connectors complying with Division 26 05 06 titled "Basic Materials and Methods" and "Section 26 05 19" titled "Wires and Cables."
 - 2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and rating, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).

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3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended for use by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

2.3 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.
- B. Class RK1 dual element time-delay fuses: Provide UL Class RK1 current limiting time-delay fuses rated 600-volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors and panelboards.
- C. Class RK5 dual element time-delay fuses: Provide UL Class RK5 current limiting time-delay fuses rated 600 volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors, and transformers.
- D. Class L time-delay fuses: Provide UL Class L time-delay fuses rated 600 volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.

2.4 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted NEMA-1 steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 1. Size: Adequate for storage of spare fuses specified in Section 3.3 with [15] <Insert number> percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Provide engraved, plastic laminate label "Spare Fuses" for cabinet. Refer to Section 26 05 53 for more information.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
- B. A complete set of spare fuses shall be purchased at the same time the initial fuses are purchased. Spare fuses shall consist of a standard carton for 0 to 60 amperes rating, and for above 60 amperes rating provide 10% of each type and rating or a set of three, whichever is greater. Spare fuses shall be placed in one or more spare fuse cabinets as required. The spare fuse cabinet shall be 30" H x 24" W x 12" D with key lock door, center shelf and fuse index holder. Include one set of fuse bulletins in the fuse cabinet.
- C. Fuses shall be U.L. Class L, time-delay and shall employ "O" rings as positive gas seals between the end bells and the glass melamine fuse barrel. Mounting terminals shall be opened. Fuses shall be time-delay and must hold 500% of rated current for a minimum of 4 seconds and clear 20 times rated current within .01 seconds. Fuse links shall consist of pure copper.

2.5 MOLDED CASE PROTECTIVE DEVICES

- A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.

- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- D. The Contractor shall perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

2.6 ENCLOSURES

- A. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 - 1. Nema 1 surface of flush-mounted general purpose enclosures intended for indoor use.
- B. All enclosed circuit breakers shall have nameplates that contain a permanent record of catalog number and maximum rating.
- C. Provide handle mechanisms that are pad-lockable in the "OFF" position.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall examine location where fuses and safety and disconnect switches and circuit breakers are to be installed and notify Architect/Engineer in writing of conditions detrimental to proper and timely/completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CIRCUIT AND DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Provide **NEMA 4XSS** disconnect switches for all exterior locations and any location subject to moisture.
- D. Provide box with spare set of each size fuse used on job.
- E. Provide nameplate on switch, indicating equipment served.

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- F. Provide line voltage wiring from starter/VFD control circuit to Aux contact in disconnect. Provide 2# 10, 3/4" C or run with power wire if same voltage.

3.3 INSTALLATION OF EQUIPMENT CONNECTIONS

- A. Install electrical connections in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of installation" to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- E. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "nicking" copper conductors while skinning wire.
- F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torque tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A.
- H. Provide PVC-coated conduit and fittings for highly-corrosive atmospheres.
- I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
- J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:
 - 1. Exterior location.
 - 2. Moist or humid atmosphere where condensation can be expected to accumulate.
 - 3. Corrosive atmosphere.
 - 4. Water spray.
 - 5. Dripping oil, grease, or water.
- K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26 section titled "Electrical Identification." Affix markers on each terminal conductor, as close as possible to the

point of connection.

- L. Provide flexible metal conduit or Type "S" rubber cords, pigtails, caps, etc., as required to constitute an operating system. All flexible cords shall have a grounding conductor. Ground all equipment. See Section 26 05 26 titled "Grounding" for additional requirements.
- M. Prior to roughing-in, refer to all equipment manufacturer's shop drawings for details of equipment connections. Provide receptacles as required to match the cord caps on the equipment furnished. Provide either direct wiring or receptacles for final connection to equipment as required for the particular equipment furnished regardless of the type of outlet shown on the plans.

3.4 INSTALLATION OF FUSES

- A. Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC, and NEMA standards for installation of fuses.
- B. Coordinate work including electrical wiring, as necessary, to interface installation of fuses with other trades.
- C. Install fuses in fused switches.
- D. Provide spare fuse cabinet located in each main switchgear room. Provide spare fuse of size and type for every five (5) fuses installed. A minimum of three (3) spare fuses shall be provided for each size installed.
- E. Contractor shall install Class R fuse rejection kits on all heavy duty safety switches not already fitted for Class R fuses.

3.5 INSTALLATION OF ENCLOSED CIRCUIT BREAKERS

- A. Install enclosed circuit breakers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Coordinate enclosed circuit breakers installation work with electrical raceway and cable work, as necessary for proper interface.

3.6 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground for electrical disconnect switches.

3.7 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect switches and circuit breakers, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

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- B. Upon completion of installation of fuses, test and inspect system to ensure compliance with requirements.
- C. Final tests and inspections of fuses shall be made prior to energization of the equipment. This shall include a thorough cleaning, tightening and review of all electrical connections and inspection of all grounding conductors.

END OF SECTION

SECTION 26 32 13

DIESEL GENERATOR SETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Extent of diesel generator set work is indicated by drawings and is hereby defined to include, but not by way of limitation, removal of diesel engine, electrical generator, engine starting system including batteries, instrument control panel, transfer switches, fuel tanks, annunciator panel, exhaust silencer, vibration isolation, wall thimble, accessories, load bank, and generator enclosure.
- B. The new transfer switch shall be furnished by the same manufacturer predominantly in use on the medical campus.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on transfer switch and components. Include manufacturer's standard product warranty, for duration of not less than two-years, for replacement of materials and equipment used in diesel generator systems.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which diesel engine-driven generator units are to be removed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Taking existing generator off line and removal must be done only after

3.2 REMOVAL OF DIESEL ENGINE-DRIVEN GENERATOR SETS

- A. Remove diesel engine-driven generator unit in accordance with recognized industry practices.
- B. Coordinate with other removal work, including raceways, control wiring, power wiring, electrical boxes and fittings, fuel tanks, piping and accessories, as necessary.

END OF SECTION

SECTION 26 36 00

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, and general provision of Contract, Instruction For Bidders, including General Conditions and Division-26 Specification sections, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Extent of transfer switch work, including associated control devices, is indicated by drawings and schedules and as specified herein.
- B. The generator and transfer switches shall be furnished by the same manufacturer.
- C. Types of transfer switches required for the project include the following:
 - 1. Automatic transfer.
- D. Refer to other Division-26 sections for wires/cables, electrical raceways, boxes and fittings, which are required in conjunction with transfer switch work; not work of this section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data and installation instructions for electrical power transfer switches.
- B. Shop Drawings: Submit 1/2"=1'-0" scale layout drawings of electrical generator and transfer switches showing accurately scaled equipment locations, housekeeping pad size, location and spatial relationships to associated electrical equipment in proximity.
- C. Wiring Diagrams: Submit wiring diagrams for electrical transfer switches, and associated control devices showing connections to prime and alternate power sources, electrical load, and equipment components. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualification: Firms regularly engaged in manufacture of electrical power transfer switches, of types, rating, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Provide automatic transfer switches produced by a manufacturer listed as an Approved Manufacturer in this section.

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- C. Provide automatic transfer switch whose performance under specified conditions is certified by the manufacturer.
- D. Service: The manufacturer must have a factory warehouse, at which spare parts are stocked and where a field service engineer permanently resides, located within 50 miles of the job site. The field service engineer shall be a full-time employee of the manufacturer, factory trained and qualified individual whose primary duty is field service.
- E. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all the requirements of this Specification. The certifications shall identify, by serial number(s), the equipment involved.
- F. Each transfer switch shall be furnished with an operator's manual providing installation and operating instructions.
- G. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing electrical power transfer switches similar to that required for this project.
- H. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of electrical power transfer switches.
 - 2. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches", and UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide transfer switches and components which are UL-listed and labeled.
 - 3. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No.'s ICS 2, "Industrial Control Devices, Controllers and Assemblies", ICS 6 and 250, pertaining to transfer switches.
 - 4. NFPA Compliance: Comply with applicable requirements of NFPA 99; "Standard for Health Care Facilities", and NFPA 101; "Code for Safety to Life from Fire in Buildings and Structures", pertaining to transfer switches. NFPA 110, NEC (NFPA 70) for construction and installation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver transfer switches and associated devices in factory-fabricated type containers or wrappings, which properly protect equipment from damage.
- B. Store transfer switches and associated devices in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
- C. Handle transfer switches and associated devices carefully to prevent physical damage to equipment. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

PART 2 - PRODUCTS

2.1 TRANSFER SWITCHES

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- A. General: Except as otherwise indicated, provide manufacturer's standard design, materials and components as indicated by published product information, designed and constructed as recommended by manufacturer for duty indicated, and as required for a complete installation.
- B. Automatic Transfer Switches shall be provided with 4 poles, current ratings as indicated on the drawings, for a normal and emergency source of 3 phase, 4 wire, 60Hz with neutral bus. The transfer switch shall be braced to have a short circuit rating of 65,000 RMS symmetrical amperes minimum, plus a short circuit rating larger than the available fault current. The transfer switches shall be listed per UL Standard 1008 as a recognized component for emergency systems and rated for total system load. The pickup voltage shall be adjustable from 85% to 98% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The switch is to be enclosed in a NEMA 1 type non-ventilated enclosure suitable for all mountings without derating. The neutral bus shall be fully rated for switch ampere rating unless otherwise noted
- C. The automatic transfer switches shall be mechanically held, electrically operated type and suitable for continuous duty in an unventilated sheet metal enclosure without derating (NEMA Type A IEC Type PC). The transfer switches shall be inherently double throw so both sets of contacts move simultaneously when the switch is transferring. The transfer switches shall be mechanically interlocked to ensure only three possible positions-normal neutral and emergency.
- D. All main contacts shall be silver alloy wiping action type. They shall be protected by arcing contacts in sizes above 400 amperes. Main contacts shall transfer in 1/6th of a second or less.
- E. All switch and relay contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panels from the enclosure and without disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous duty industrial control type with minimum contact rating of 10 amperes.
- F. All relays, control wiring and accessories shall be front accessible. The voltage sensing relays and all adjustable timers shall be capable of being adjusted, while energized, through calibrated dials. Sensing relays shall operate without contact chatter or false response when voltage is slowly varied to drop out and pick up level. The switch shall be capable of handling all classes of loads as required for the application.
- G. Automatic transfer switches utilizing components of molded case circuit breakers, circuit interrupters, disconnect switches, or parts thereof which had not been intended for repetitive switching are not acceptable. An overload or short-circuit shall not cause the transfer switch to go into neutral position.
- H. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0.5 to 15 seconds and factory set at 3 seconds.
- I. The switch shall transfer the load to the emergency power system after the generator set reaches proper voltage and frequency. Time delay transfer to emergency power adjustable from 0 to 120 seconds (set at 5 seconds) shall allow the engine-generator set to stabilize before application of load.
- J. A time delay on retransfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and factory set at 15 minutes.

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- K. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 98% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal.
- L. Each individual transfer contact switch shall be arranged to close a pilot contact to initiate remote starting of standby plant after specified time delay upon normal source failure or after drop in voltage on any phase to 80% or less. Upon signal from automatic transfer switch, engine shall crank, start, obtain operating speed and be ready to accept load within ten seconds. When the standby plant is delivering not less than 90% of rated voltage and frequency, the load shall be transferred. This operation shall take place within 10 seconds of the loss of normal power. Upon restoration of the normal source to not less than 90% of rated voltage on all phases, the load shall be transferred to the normal source after specified time delay. Upon retransfer to normal source, engine shall remain running for a predetermined time for "cool-out" and/or protection against additional failure of normal source.
- M. Transfer switch shall be factory equipped with a means to prevent large inrush currents due to transfer between energized sources. This feature shall provide a field adjustable time delay during switching in both directions, during which time the load is isolated from both power sources, to allow residual voltage of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. The programmed transition feature shall have an adjustable time range of 0 to 7.5 seconds. All transfer switches specified to be supplied without programmed transition shall be capable of addition of the programmed transition feature in the field without transfer switch replacement. Transfer methods that use the phase relationships between the two power sources to control a transfer initiation time are not acceptable.
- N. The automatic transfer switch shall be UL listed as complete transfer switch in accordance with UL 1008, latest edition. UL listing on the individual power switch devices above is not sufficient. Transfer switches utilizing components of molded case circuit breakers, circuit interrupters, disconnect switches etc., will not be acceptable. The automatic transfer switch shall be warranted for a period of two years from date of acceptance.
- O. A contact that closes when normal source fails for initiating engine starting, rated 10 amps, 32 volt D.D. Contacts to be gold plated for low voltage service.
- P. Pilot lights to show switch position.
- Q. One set of normally open and one set of normally closed auxiliary contacts.
- R. A test switch to momentarily simulate normal source failure.
- S. Harnessing between transfer switch and control panel shall have built-in disconnect for routine maintenance.
- T. Transfer switch shall be furnished with an operator's manual providing installation and operating instructions.
- U. Transfer switch shall be supplied in a NEMA 1 enclosure.
- V. Transfer switch shall be furnished with an adjustable exerciser circuit. Selectable exercise time of the day of month, time of day, and duration shall be provided.
- W. The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be a built-in microprocessor-based system for maximum reliability, minimum maintenance, and inherent digital communications capability. The control settings shall be

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stored in nonvolatile EEPROM. The module shall contain an integral programmable clock and calendar. The control module shall have a keyed disconnect plug to enable the control module to be disconnected from the transfer mechanism for routine maintenance. The control module shall be mounted separately from the transfer mechanism unit for safety and ease of maintenance. Interfacing relays shall be industrial control grade plug-in type with dust cover.

- X. The control module shall include programming keypad, alpha-numeric display for monitoring settings and diagnostic values, key-lockable program selector switch, light-emitting diode status indications, and user instructions. These features shall be user accessible when the enclosure door is closed.
- Y. The control module shall be capable of storing the following records in memory for access either locally (at the control module) or remotely (at a computer):
 - 1. Number of hours transfer switch is in the emergency position (total and since record reset).
 - 2. Number of hours the emergency is available (total and since record reset).
 - 3. Total transfers in either direction (total and since record reset).
 - 4. Date of record reset.
 - 5. Date of last exercise period.
 - 6. Date, time, and description of the last four source failures.
 - 7. Elapsed time during the most recent source outage.
- Z. The following additional accessories shall be provided:
 - 1. Adjustable time delay to override momentary outage for six (6) seconds.
 - 2. Adjustable time delay 2-25 minutes on retransfer to normal source with 5 minute unloaded running time of standby plant. In the event of a general failure transfer switch will nullify the time delay and return to normal.
 - 3. Momentary test switch with the following positions:
 - a. Test
 - b. Automatic
 - 4. Engine starting contact.
 - 5. Indicating lights - mount in cover of enclosure to indicate switch in either normal or emergency position.
 - 6. Auxiliary contacts, one closed on normal position, the second closed on emergency position.
 - 7. All time delay and sensing functions shall be readily field adjustable over the ranges indicated and operate without drift over a temperature range of minus 4°F. to 158°F.
 - 8. Time delay on transfer to emergency for controlled loading of generator 0-1 minutes, set at 0 minutes.
 - 9. Return to normal switch - mount in cover of enclosure to initiate manual transfer from alternate to normal power source.
- AA. During the withstand tests, there shall be no contact welding or damage. The circuit breaker coordination tests shall be performed without the use of current limiting fuses, and oscillograph traces across the main contacts shall be furnished to verify that contact separation has not occurred. Test procedures shall be in accordance with UL 1008, and testing shall be certified by Underwriters' Laboratories, Inc. or a nationally recognized Independent Electrical Testing Laboratory. When conducting temperature rise test to Paragraph 17 of UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
- BB. An operational test shall be conducted after installation to indicate that each switch will operate

satisfactorily under all conditions required by the Specifications. This shall be done in the presence of the Architect's representative.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which transfer switches are to be installed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFER SWITCHES

- A. Install transfer switches, including associated control devices as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that transfer switches comply with requirements. Comply with applicable requirements of NEC and NFPA pertaining to wiring practices and installation of electrical power transfer switches.
- B. Coordinate with other electrical work, including raceway, and electrical boxes and fittings, as necessary to interface installation of transfer switch work with other work.
- C. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.
- D. Anchor mounting hardware firmly to walls, floors, or ceilings, to ensure enclosures are permanently and mechanically secured. Provide all hardware and accessories for proper mounting.
- E. Provide in conjunction with each and every automatic transfer switch the following:
 - 1. 2# 12-1/2" C from auxiliary contact (closed when switch in emergency position) on transfer switch to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
 - 2. 2# 12-1/2" C from auxiliary contact (closed before switch returns to normal power) on transfer switch serving elevators to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
 - 3. 2# 12-1/2" C from engine start contact on transfer switch to respective emergency generator control panel.
 - 4. 2# 12-1/2" C from auxiliary contacts on fire pump controller for generator start.
 - 5. Wiring as necessary from transfer switch to remote annunciator panels and engine control panel for transfer switch position indicator lights.
- F. Provide all necessary wiring and conduit to each remote alarm panel located at the building command center.

3.3 GROUNDING

- A. Provide equipment grounding connections for transfer switch units as indicated. Tighten connectors to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL

- A. Test transfer switches, by means of simulated power outage; automatic start-up by remote-automatic starting, transfer of load and automatic shutdown. Prior to these tests, adjust transfer switch timers for proper system coordination.
- B. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of transfer switches with requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting, where necessary, at no cost to Owner.

3.5 PERSONNEL TRAINING

- A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating transfer switches an auxiliary equipment.

END OF SECTION