DIVISION 26 – ELECTRICAL

PART 1 - GENERAL

1.1 TIME, MANNER, AND REQUIREMENTS FOR SUBMITTING SUB-BIDS

A. Sub-bids shall be submitted in accordance with provisions of the General Laws (Ter. Ed.), Chapter 149.

B. Each Sub-Bid filed with the Awarding Authority must be accompanies by BID BOND, CASH or CERTIFIED CHECK, or a TREASURER'S CHECK or CASHIER'S CHECK issued by a responsible bank or trust company, payable to the Commonwealth of Massachusetts in the amount stipulated in the INSTRUCTIONS TO BIDDERS. A Sub-Bid accompanied by any other form of bid deposit than those specified will be rejected.

C. Each Sub-Bid submitted for the work, under this SECTION, shall be on a form furnished by the Awarding Authority, as required by SECTION 44F of Chapter 149 of the General Laws, as amended.

D. The work to be done under this Section is shown on the following drawings numbered:

DRAWING LIST

SHEET NUMBER	SHEET NAME
E000	ELECTRICAL LEGEND
E001	ELECTRICAL LEGEND, NOTES, AND ABBREVIATIONS
E110	ELECTRICAL BASEMENT POWER DEMOLITION PLAN
E111	ELECTRICAL SITE POWER DEMOLITION PLAN
E301	ELECTRICAL SITE POWER PLAN
E310	ELECTRICAL BASEMENT POWER PLAN
E700	ELECTRICAL SCHEDULES AND RISER DIAGRAM
E900	ELECTRICAL DETAILS

1.2 GENERAL REQUIREMENTS

A. Refer to the drawings for further definition of location, extent, and details of the work described herein.

B. Cooperate and coordinate with all trades in execution of the work described in this Division, so as to provide coordination with all trades for items such as - clearance for equipment maintenance & operation, proper voltages, correct receptacle types, etc.

C. Where referred to, standard specifications of technical Societies, Manufacturer's Associations, and Federal Agencies shall include all amendments current as the date of issue of these Specifications.

D. It is intended, for the guidance of the bidders, that the Manufacturer's name used first throughout this Division of the Specification, is that used in the design of the Electrical system. All material submitted shall be equal in all respects to that used in the design.

E. The Subcontractor for work of this Division shall become familiar with other Divisions of the Specifications to determine the type and extent of work there under which affects the work of this trade, whether or not such work is specifically mentioned in this Division.

1.3 WORK INCLUDED

A. Examine all Drawings and other Divisions of Specifications for requirements that affect work of this Division 26.

B. Perform work and provide materials and equipment as shown on the Drawings and as specified herein. Work shall include, but not be limited to, all labor, materials, tools, equipment, insurance, transportation, temporary protection, supervision, and incidental items required for a complete installation. Drawings and specifications form complimentary requirements; provide work specified and not shown on drawings and work shown on drawings and not specified as though explicitly shown on both. Completely coordinate work of this Division with work of other Divisions and Trades to provide a complete and functional installation.

C. Provide all labor, equipment, material, implements and materials required to furnish and install all Electrical work, complete as shown on the drawings and noted herein. The following are major items of work included:
1. Hoisting and rigging for equipment and materials specified herein.
2. Core drilling, cutting and channeling for holes five (5) inches and less in diameter.
3. Furnish and maintain in safe and adequate condition, all staging and scaffolding that is required for work of this Division.

1.4 INTENT

A. Description in the Specifications, or the indication on the Drawings of equipment, materials, operation and methods, required that such items shall be of the quantity required, and the systems complete in every respect.

B. The Specifications shall be considered an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified. In the case of a conflict, the more demanding item shall apply.

C. The Electrical Contractor shall be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. The Electrical Contractor shall provide fully qualified personnel to fulfill this requirement. The Electrical Contractor shall be responsible for prompt replacement of defective materials, equipment and parts of equipment and related damages.

1.5 RELATED WORK

A. Examine all other Divisions of the Specifications and all drawings for the relationship of the work under this Division and the work of other trades. Cooperate with all trades and coordinate all work under this Division therewith.

B. The following related items are included under Divisions listed below:
1. The Electrical Contractor shall review in detail DIVISION 1 – GENERAL REQUIREMENTS and include alternate pricing in the bid as required by BIDDING REQUIREMENTS, CONTRACTING REQUIREMENTS, and applicable parts of DIVISION 1 – GENERAL REQUIREMENTS. Any exclusions shall be clearly outlined in the bid otherwise all related work and costs shall be included.
2. Except as specified herein, cutting shall be the responsibility of the General Contractor and patching shall be performed by the respective trades. Refer to the respective Divisions.

3. The Electrical Contractor shall provide all hoisting and rigging for equipment and materials specified herein.
4. The Electrical Contractor shall provide all core drilling, cutting and channeling for electrical equipment requiring holes five (5) inches and less in diameter.
5. The Electrical Contractor shall furnish and maintain in safe and adequate condition, all staging and scaffolding that is required for work of this Division.
6. The Electrical Contractor shall provide all fire stopping related to Division 26 work.
7. Fire and Smoke stopping at penetrations through fire-rated assemblies.
8. The Electrical Contractor shall seal all penetrations through non-rated walls, ceilings, floors, etc. related to Division 26 work.

1.6 STANDARD OF MATERIALS AND WORKMANSHIP

A. Conditions of the Contract and Division 1, General Requirements, shall be made part of this Section:
1. Workmanship and installation methods shall conform to the highest standard practice. Work shall be performed by skilled tradesmen under the direct supervision of fully qualified personnel.
2. Install equipment in strict accordance with manufacturer’s published recommendations.
3. When requested, submit samples of materials proposed for review before proceeding with the work.
4. Install equipment and materials to present a neat appearance. Install ducts and conduit parallel with or perpendicular to building planes.
5. Conceal conduit and cables in finished areas. Install work so as to require a minimum amount of furring.
6. Equipment, materials and work shall comply with the requirements of generally recognized agencies, including, but not limited to, agencies listed under DIVISION 26 Article CODES, STANDARDS AND REGULATIONS and shall conform to and be installed in strict accordance with Federal, State and City/Town requirements and shall meet all of the requirements of all authorities having jurisdiction.

1.7 ABBREVIATIONS AND DEFINITIONS

A. “EC” as mentioned herein means specifically “Electrical Contractor” when used in conjunction with contractor, equipment, work or articles within this specification.

B. “Provide” may be used in place of “furnish and install” and where used shall mean to deliver, furnish, erect, and connect up complete in readiness for regular operation, the particular work or equipment referred to, unless otherwise specified.

C. The term “Applicable Division Contractor” or “A.D.C.” shall be understood to refer to a contractor or contractors’ other than the E or any Electrical Subcontractor.

D. “Shown on drawings" as used in the specifications shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.

E. “Provide" as used in the specifications and on the drawings, shall mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated.

F. “Material" as used in the specifications shall mean any "product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.

G. "Approved" or "Approval" shall mean the written approval of the Architect.

H. "Contract Documents" shall mean the entire set of Drawings and Specifications as listed in the Table of Contents of the General Conditions including all bound and unbound material and all items officially issued to date such as addenda, bulletins, job modifications, sketches, etc.

I. “Specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.

J. "Accessible" shall indicate ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, etc. to gain access. "Accessible Ceiling" indicates acoustic tile type hung ceilings. Concealed spline or sheetrock ceilings with access panels shall not be considered accessible ceilings.

K. "Concealed" shall mean hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.

L. "Exposed" shall mean not installed underground or "Concealed" as defined above.

M. "Electrical Subcontractor" shall refer to the Subcontractor responsible for furnishing and installation of all work indicated on the Electrical Drawings and in the Electrical Specifications.

N. "Owner" shall refer to the Owner or his designated representative.

1.8 EXAMINATION

A. Examine the Specifications and Drawings, including the Specifications and Drawings of other DIVISIONS before bid.

B. Before submitting bid, visit and examine the site where work is to be carried out and become familiar with all features and characteristics that affect the work of this DIVISION.

C. Report in writing, any discrepancies or deficiencies which may adversely affect the work, at least six days prior to close of bid.

D. No allowance will be made for any difficulties encountered due to any features of the building, site or surrounding public and private property that existed up to the time of bid.

1.9 CODES, STANDARDS, AND REGULATIONS

A. Electrical work shall comply with the latest editions of the following codes which have been accepted by local authorities:

1. IBC – International Building Code with State Amendments
2. Massachusetts Amendments to the International Building Code (780 CMR)
3. International Energy Conservation Code (IECC) with State Amendments
4. NFPA 70 - National Electrical Code with State Amendments
5. NFPA 70E - Standard for Electrical Safety in the Workplace

B. Electrical work shall comply with the current standards of the following organizations:
1. ADA - Americans with Disabilities Act
2. IEEE - Institute of Electrical and Electronics Engineers
3. OSHA - Occupational Safety and Health Act

4. UL - Underwriters' Laboratories
5. ANSI - American National Standards Institute
6. NEMA - National Electric Manufacturers Association
7. ASTM - American Society for Testing and Materials
8. Owner's Insurance Underwriter
9. ANSI/NECA 1-2010 – Standard Practice for Good Workmanship in Electrical Contracting.

C. When requirements listed in this Division conflict with each other, with the contract documents or with the requirements of applicable Codes, Standards or Regulations, the most stringent requirements shall apply.

D. In addition to complying with the specified requirements, comply with pertinent regulations of governmental agencies and Authorities Having Jurisdiction (AHJ) including local and state building, plumbing, mechanical, electrical, fire, and health department codes and standards.

1.10 DRAWINGS

A. The Drawings are schematic in nature and are intended to show approximate locations of apparatus, fixtures, devices conduit run, etc. in diagrammatic form. The Drawings are not intended to show Architectural and Structural details.

B. Do not scale drawings. Obtain any information requiring accurate dimensions from Architectural and Structural Drawings or from site measurements. Check locations and elevations before proceeding with work.

C. At no additional cost to the Owner, make all changes or additions to materials and/or equipment necessary to accommodate structural and architectural conditions.

D. Leave areas clear and unobstructed where space is indicated as reserved for future equipment.

E. Whether shown on the Drawings or not, provide adequate code required clearances, space and provision for servicing of equipment, removal and reinstallation.

1.11 FABRICATION OF MATERIALS

A. Before prefabricating equipment for installation, make certain that such items can be installed as shown on the Drawings without interfering with the structure or the work of other trades. Any problems that cannot be solved in agreement with other trades affected, shall be submitted for decision.

B. If equipment is prefabricated prior to the investigation and reaching of a solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Owner.

C. In case of any discrepancies between the Specifications and Drawings, or where the Specifications or Drawings are not clear or definite, the subject shall be referred to or decided by the Architect whose decision shall be final. Otherwise, make adjustments at no expense to the Owner.

1.12 PERMITTING AND CHARGES

A. Apply for, obtain and pay for all permits, inspections and fees required.

B. Be fully acquainted with and obey all Federal, State, and Municipal laws, by-laws, codes and regulations, and all authorities having jurisdiction.

C. Before starting any work, submit the required specifications and Drawings to the Governing Authorities for their approval. Comply with any requested changes as part of the Contract, and give any notification immediately of such changes.

D. Where the Specifications, Instructions, or the Governing Authorities require any work to be tested, inspected or approved, give sufficient notice of its readiness for inspection, and, if the inspection is by a Governing Authority, of the date and time set for such inspection.

E. Inspection will be made promptly. If any work is covered up without consent, it shall, if required, be uncovered for examination and the required corrections made at no extra cost to the Owner.

F. Furnish any certificates necessary as evidence that the work conforms to the requirements of all authorities having jurisdiction.

G. Make changes, if required, to make the work conform to all laws, bylaws, codes, and regulations, as part of DIVISION 26 work.

H. Electrical Contractor shall give all necessary notices, file and obtain all permits, pay all governmental taxes and fees. Contractor shall also obtain all required Certificates of Inspection for his respective work and deliver same to Owner's Representative before request for acceptance of his portion of work is made and before final payment.

1.13 SUBMITTALS

A. General: The required shop drawing submittals shall be reviewed and returned for two full or partial submissions as part of the base Engineering scope of services.

B. Substitutions: The Division 26 contractor shall submit on the system, components, materials, manufacture, etc. utilized by the Engineer as the "Basis of Design." The contractor shall be allowed to utilize one of the listed manufacturers for items that are not listed with a "Basis of Design." When a substitution is allowed by the Architect and/or Engineer it shall be the full responsibility of the Division 26 contractor to coordinate all differences with field conditions, owner, owners' representatives, commissioning agent, other trades, etc. Any costs and schedule delays due to changes, modifications, redesigns, removal and replacement created by the contractors' substitution or failure to coordinate substitution shall be the responsibility of the contractor.

C. Present, not later than three (3) weeks after award of the Contract, a list of Shop Drawings shall be submitted with the name of each manufacturer and supplier. Failure to submit this list will result in the necessity for the Contractor to use that equipment which is scheduled.

D. Shop drawings of equipment furnished under this Division shall include, but not be limited to, all items listed under Division 26 – "WORK INCLUDED" and listed within this specification.

E. Do not manufacture, deliver or install equipment and materials until final review of Shop Drawings has been completed.

F. Prior to submission of Shop Drawings, the Electrical Contractor shall thoroughly check each shop drawing to ascertain that it complies with the Contract requirements; that the electrical characteristics are correct; and that the dimensions of work submitted fit the available space. Any deviations from the Contract requirements shall be clearly noted on the Shop Drawings. The Electrical Subcontractor shall stamp each submittal with his firm's name, date and approval,

thereby representing that the above has been complied with. Shop Drawings not so checked and stamped, shall be returned without being examined by the Architect. Review of the Shop Drawings shall not relieve the Electrical Contractor from the responsibility for departures from the Contract Documents. Errors in shop drawings shall be the sole responsibility of the Electrical Subcontractor whether the drawings are reviewed or not.

G. Shop drawings shall be submitted in groups by systems. For example, all lighting fixtures, and accessories shall be submitted simultaneously in one package.

H. Submit for review either electronically or in hard copy format to comply with the requirements of Division 01 and the agreed upon submittal process at project kickoff. Submit all shop drawings and certified submittals for equipment, materials, equipment wiring, diagrams, motors, starters, controls and schedules. Ensure that shop drawings have adequate clear space for all stamps. When requested, resubmit drawings promptly.
   1. If submitting electronically, provide email notification to ftconadmin@f-t.com with submittal file(s) attached in industry standard ".pdf" file format. Ensure that shop drawings with native page size larger than 8 ½" x 11" are included at their native size and legible. If the submittal file(s) are too large for email transfer, provide hyperlink to files allowing both download and upload of files over internet connection without requiring use of usernames or passwords.
   2. For hard copy format, submit full size copies of each Shop Drawing larger than 8 ½" x 11" and seven (7) copies of smaller certified Shop Drawings.

I. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, with project specific information indicated.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's written recommendations.
      b. Manufacturer's product specifications.
      c. Manufacturer's installation instructions.
      d. Dimensions and Required clearances
      e. Equipment Shipping and Operating weights and Structural Loads.
      f. Components required for field installation.
      g. Method of field assembly, components, and location and size of each field connection.
      h. Field electrical connection requirements.
      i. Notation of coordination requirements.
      j. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring
      k. Color charts.
      l. Manufacturer's catalog cuts.
      m. Wiring diagrams showing factory-installed wiring.
      n. Certified performance ratings with system operating conditions indicated.
      o. Certified compliance with specified referenced standards. Testing by recognized testing agency.
      p. Standard product operation and maintenance manuals.
      q. Notation of coordination requirements.
      r. Submit certified discharge and radiated sound power levels for:
         1) Generators

J. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data. Prepare shop drawings for all custom equipment such as switchgear, generators, transfer switches, and any equipment that standard manufacturers printed data is not suitable for use.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Dimensions.
   b. Equipment Shipping and Operating weights.
   c. Identification of products.
   d. Fabrication and installation drawings.
   e. Roughing-in and setting diagrams.
   f. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.

K. Be responsible for presenting the processing of shop drawings to suit manufacturing schedule of equipment and construction schedule of building.

L. Be responsible for the accuracy of equipment dimensions relative to available space, the performance and the electrical characteristics. When required, submit a complete comparison between accepted alternative equipment and materials, and that which is specified.

M. Each Shop Drawing shall indicate clearly the correct name and address of the project, the intended use and location of the equipment, and the specified designated number.

N. Submit certified Shop Drawings and distribute prints to all trades and manufacturers affected.

O. Upon receipt of approved Shop Drawings, distribute prints to all trades and manufacturers affected.

P. Keep one set of reviewed Shop Drawings on the site at all times.

Q. Bind one set of the corrected “Reviewed” Shop Drawings in each Operation and Maintenance Instructions Manual. Refer to DIVISION 01 - SUBMITTALS, DIVISION 01 - PROJECT CLOSEOUT.

R. Provide information to other Contractors as required of concrete equipment bases and for any other work to be performed by other trades.

S. The Electrical Contractor shall submit to the General Contractor, for transmittal to the Owner, any samples requested by the Owner. Submittal, review, and approval of samples shall be in accordance with the Conditions of the Contract.

1.14 REQUESTS FOR INTERPRETATION (RFIs)

A. Prepare Requests for Interpretation (RFIs) in accordance to Division 01 and, in addition, adhere to the following:

B. RFIs shall originate with the Contractor. RFIs submitted directly by sub-contractors will be returned with no response. RFIs sent directly to engineer will be returned with no response. Incomplete RFIs will not be reviewed and will be returned for additional information.

C. If email RFI submissions are allowed by Division 01 then the RFI and Attachment(s) shall be in Adobe Acrobat PDF format.

D. Submit RFIs in format specified and in addition include:
   1. Specification Division number and title and related paragraphs, as appropriate.
   2. Drawing number, room name, structural grid coordinates and detail references, as appropriate.

3. Field dimensions and conditions, as appropriate.
4. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
5. Attachments: Include 8 ½" x 11" copies of construction documents highlighting areas requiring interpretation. Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation and suggested solution(s).
    a. Supplementary drawings prepared by Contractor shall be to scale and shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.

1.15 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate installed conditions for:
1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.16 OPERATION AND MAINTENANCE DATA

A. Prepare maintenance manuals in accordance with Division 01 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 01, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

B. The minimum information that shall be furnished in the maintenance manual shall include the following:
1. Individual characteristics for trouble shooting sequences for each item of each:
    a. Packaged engine generators.
    b. Transfer switches, automatic and manual.
2. Catalog cut sheets for every item for which a shop drawing is required.
3. Schedule of loads served from each:
    a. Packaged engine generators.
    b. Transfer switches, automatic and manual.
4. On-hand spare parts list and complete parts list for each:
    a. Packaged engine generators.
    b. Transfer switches, automatic and manual.
5. Bolt tightening torques and inspection intervals on each:
    a. Bolted bus connection.
    b. Cable connection.
    c. Miscellaneous bolted electrical connections.
6. Main and arcing contact adjustment and replacement for each:

a. Automatic transfer switch.
b. Contactor.
c. Circuit breaker.

7. Calibration and exercise procedures and intervals for each:
   a. Automatic transfer switch.
   b. Generator set.
   c. Molded case breaker.
8. "As designed" and "as left" adjustable circuit breaker settings.
9. Testing interval and target values for ground fault protection circuit relays.
10. Testing and troubleshooting procedures unique to special systems.
11. Approved special construction details that differ from the details shown on Drawings.

1.17 ELECTRICAL BASIS OF DESIGN

A. For major pieces of electrical equipment, including but not limited to transfer switches, generators, etc., the engineer's basis of design is the unit shown on the plans, listed in the schedules and outlined in the specification. The contractor may submit an alternate unit from the list of approved manufacturers in this specification IF he ensures that such unit has electrical, illumination, control, etc. performance equal to or better than the scheduled unit and IF he ensures that the unit fits within the allotted electrical space.

B. For equipment supported by the buildings structure or an architectural element the contractor must ensure that the submitted unit either weighs less than the scheduled unit or can be supported by the roof structure.

C. Electrical characteristics of submitted equipment must match those of scheduled equipment. This means that voltages, phases and hertz of submitted equipment must be the same as scheduled equipment.

1.18 CONNECTIONS TO EQUIPMENT

A. The Electrical Contractor shall provide all electrical and control connections to equipment provided under other Divisions of the specifications as shown on the contract documents and herein specified including final connections to equipment to result in a complete system, fully operational. Coordinate the locations of all equipment with Architect. Obtain installation diagrams and methods of installation of all equipment from manufacturers. Follow instructions strictly.

1.19 COORDINATION

A. Fully coordinate with other trades to ensure that work is carried out in the best interests of all concerned. Install work in proper sequence to conserve headroom and space.

B. Coordinate work with other trades to provide maximum accessibility for maintenance and operation of all equipment installed by all trades.

C. Give notices of requirements for holes, recessed openings and chases.

D. Furnish all items to be built-in, in ample time to allow scheduled progress of work.

E. Refer to the Coordination Drawing Section of Specification for Coordination drawing process.

1.20 IDENTIFICATION OF ELECTRICAL SYSTEMS

A. Identify all electrical systems. Use terminology consistent with the Drawings and Specifications.

B. Labeling of new systems added to existing systems shall be consistent with the existing numbering system and terminology. Do not use valve numbers that have already been used.

C. Labeling on all exposed conduit shall be on top of the conduit out of line of sight.

D. Provide typewritten master lists in Operating and Maintenance Instruction Manuals; and shop equipment numbers on Record Prints and sepias.

E. Identification shall be consistent with Owner's standard methods of identification.

1.21 PROTECTION

A. Protect all electrical equipment, system and work from damage. Keep all equipment dry and clean at all times.

B. Cover openings in equipment, and conduits, with caps or heavy gauge plastic sheeting until final connections are made.

C. Correct at no cost to the Owner, any damage caused by improper storage, handling, or installation of equipment and materials.

D. Protect equipment, conduit and temporary services installed within Division 26 from weather damage.

1.22 GUARANTEE

A. Conform to the requirements of Division 01 Section "Project Close-out."

B. All equipment, material and workmanship shall be unconditionally guaranteed, as set forth in the Contract, or for longer periods when stated in the Specifications. Extensions to the standard equipment warranty periods shall be arranged by the Electrical contractor to enable the period to commence upon beneficial usage by the Owner.

C. If any equipment or material does not match the manufacturer's published data or specifically supplied rating schedules during performance tests, replace without delay the defective equipment or materials. Bear all associated costs and adjust all components at no charge to the Owner and adjust all components to achieve the proper rating.

D. Correct defects and deficiencies, and pay for resulting damage to Mechanical or other work, and to property and person, which appear or originate during the guaranteed period

E. The Owner shall give notice of observed defects promptly in writing.

1.23 DEMOLITION

A. The following systems shall be included for demolition as part of this project:
   1. Packaged engine generators.
   2. Transfer switches, automatic and manual.

3. Grounding.
4. Raceways and boxes.
5. Raceway support system.
6. Conductors and cables.
7. Control / signal conductors.
8. Electrical Supporting devices.
9. Pull boxes.
10. Junction boxes.
11. Electrical identification, including but not limited to, nameplates, device markings, cable and conduit identification, etc.
12. Fire-stopping.

B. The Electrical Contractor shall de-energize and make safe all electrical systems required to be demolished. Electrical equipment scheduled to be maintained or relocated shall be removed, stored, cleaned, and repaired prior to re-installation – this is the responsibility of the Electrical Contractor.

C. The Electrical Contractor shall be responsible to understand the wiring and continuity of all systems and system wiring prior to demolition or removal. System wiring providing service to areas outside the area of construction shall be maintained in such a manner that will not impact the full operation of the building/facility.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.
1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
2. Metal Items for Use in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.

B. Steel channel supports have 9/16-inch diameter holes at a maximum of 8 inches O.C., in at least (1) surface.
1. Fittings and accessories mate and match with channels and are from the same manufacturer.

C. Raceway and Cable Supports: Manufactured hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps or "click"- type hangers.

2.2 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
1. Wires and Cables:
   a. Southwire Company
   b. General Cable Company (Carol & BICC)
   c. AFC Cables Systems, Inc

2. Connectors for Wires and Cables:
    a. AFC Cables Systems, Inc
    b. O-Z Gedney (Emerson Industrial Automation)
    c. 3M Company; Electrical Products Division
    d. Thomas & Betts Corporation

B. Building Wires and Cables
1. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 “INSTALLATION OF CONDUCTORS AND CABLES”, "Wire and Insulation Applications" paragraph.
2. Rubber Insulation Material: Comply with NEMA WC 3.
3. Thermoplastic Insulation Material: Comply with NEMA WC 5.
4. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
5. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
6. Conductor Material: Copper.
7. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.

C. Connectors and Splices
1. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 “INSTALLATION OF CONDUCTORS AND CABLES”, "Wire and Insulation Applications" paragraph.

2.3 RACEWAYS AND BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Metal Conduit and Tubing:
    a. Alflex Corp.
    b. Anamet, Inc.; Anaconda Metal Hose.
    c. Anixter Brothers, Inc.
    d. Carol Cable Co., Inc.
    e. Electri-Flex Co.
    f. Flexcon, Inc.; Coleman Cable Systems, Inc.
    g. Allied Tube and Conduit ~~Div~~. (Atkore International)
    h. Wheatland Tube Co. (JMC Steel Group)
    i. Western Tube & Conduit Corporation
2. Conduit Bodies and Fittings:
    a. American Electric; Construction Materials Group.
    b. Crouse-Hinds; Div. of Cooper Industries.
    c. Emerson Electric Co.; Appleton Electric Co.
    d. Hubbell, Inc.; Killark Electric Manufacturing Co.
    e. Lamson & Sessions; Carlon Electrical Products.
    f. O-Z/Gedney; Unit of General Signal.
    g. Scott Fetzer Co.; Adalet-PLM.
    h. Spring City Electrical Manufacturing Co.
3. Boxes, Enclosures, and Cabinets:
    a. Crouse-Hinds; Div. of Cooper Industries.
    b. Electric Panelboard Co., Inc.
    c. Erickson Electrical Equipment Co.
    d. Hoffman Engineering Co.; Federal-Hoffman, Inc.
    e. Hubbell Inc.; Killark Electric Manufacturing Co.
    f. Hubbell Inc.; Raco, Inc.
    g. Lamson & Sessions; Carlon Electrical Products.

h. O-Z/Gedney; Unit of General Signal.
i. Thomas & Betts Corp.

B. Metal Conduit And Tubing
1. Rigid Steel Conduit: ANSI C80.1.
2. IMC: ANSI C80.6.
3. EMT and Fittings ANSI C80.3.
a. Fittings: Compression type for conduit size up to 1 ¼“, steel set screw type for conduit size 1 ½“ and above.
4. FMC: Zinc-coated steel.
5. LFMC: Flexible steel conduit with PVC jacket.
6. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

C. Pull and Junction Boxes
1. Small Sheet Metal Boxes: NEMA OS 1.

2.4 ELECTRICAL IDENTIFICATION

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:
1. Brother Labelers
2. Brady USA, Inc.; Industrial Products Div.
3. Ideal Industries, Inc.
4. Dymo - Rhino.
5. Seton Identification Products

B. Engraved Nameplates And Signs
1. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
2. Engraving stock, melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 sq. in., 1/8 inch thick for larger sizes.
a. Engraved Legend: Black letters on white face.
b. Punched for mechanical fasteners.
3. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for the application. 1/4-inch grommets in corners for mounting.
4. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.
5. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

C. Miscellaneous Identification Products
1. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties with the following features:
a. Minimum Width: 3/16 inch.
b. Tensile Strength: 50 lb minimum.
c. Temperature Range: Minus 40 to 185 deg F (Minus 4 to 85 deg C).
d. Color: As indicated where used for color coding.

2.5 GROUNDING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
   1. Chance: A. B. Chance Co.
   2. Erico Inc.; Electrical Products Group.
   3. ILSCO.

B. Grounding and Bonding Products
   1. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Wire and Cable Grounding Conductors
   1. Comply with Division 26 Section "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
      a. Material: Copper Only.
   2. Equipment Grounding Conductors: Insulated with green color insulation.
   3. Grounding-Electrode Conductors: Stranded cable.
   4. Bare Copper Conductors: Conform to the following:
      a. Solid Conductors: ASTM B 3.
      b. Assembly of Stranded Conductors: ASTM B 8.
      c. Tinned Conductors: ASTM B 33.
   5. Miscellaneous Conductors
      a. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
      b. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
      c. Bonding Straps: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.
   6. Connector Products
      a. Pressure Connectors: High-conductivity-plated units.
      b. Bolted Clamps: Heavy-duty type.
      c. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6 PACKAGED ENGINE GENERATOR

A. General: The project requires one diesel fueled, exterior, generator located on grade. The generator shall be located in a sound-attenuated, weatherproof, factory enclosure, and shall include an integral base-mounted, double-walled fuel tank with storage capacity for a minimum 24 hour run time at full load. The generator shall include a local control panel within the generator enclosure and shall interface with a remote annunciator and control station located adjacent to the fire alarm annunciator.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar, Inc.; Engine Division.
   2. Cummins Power Generation
   3. Kohler Company; Generator Division.

C. Service Conditions
   1. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

a. Ambient Temperature: Minus 15 deg C to plus 40 deg C.
b. Altitude: Sea level to 1000 feet.

D. Engine Generator
1. Furnish a coordinated assembly of compatible components.
2. Ratings: Voltage, frequency, and power output ratings of system are as indicated.
3. Output Connections: 3 phase, 4 wire.
4. Safety Standard: Comply with ASME B15.1.
5. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of item.
6. Power Output Rating: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
7. Skid: Adequate strength and rigidity to maintain alignment of mounted components without dependence on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.
8. Rigging Diagram: Inscribed on a metal plate permanently attached to skid. Diagram indicates location and lifting capacity of each lifting attachment and location of center of gravity.

E. Engine
1. Comply with NFPA 37.
2. Fuel: Diesel fuel oil grade DF-2.
3. Maximum Engine Speed: 1800 rpm.
4. Maximum Piston Speed for 4-Cycle Engines: 2250 fpm (11.4 m/s).
5. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on the engine or skid:
   a. Filter and Strainer: Rated to remove 90 percent of particles 5 microns and smaller while passing full flow.
   b. Oil Cooler: Maintains lubricating oil at manufacturer's recommended optimum temperature throughout 2 hours of operation of generator set at 110 percent of system power output rating.
   c. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is capable of full flow and is designed to be fail-safe.
   d. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without the use of pumps or siphons or special tools or appliances.
6. Engine Fuel System: Comply with NFPA 30. System includes the following:
   a. Integral Injection Pumps: Driven by engine camshaft. Pumps are adjustable for timing and cylinder pressure balancing.
   b. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
   c. Parallel Fuel Oil Filters: Ahead of injection pumps. Changeover valves allow independent use of either filter.
   d. Relief/Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
7. Jacket Coolant Heater: Electric-immersion type, factory installed in jacket coolant system. Unit is rated and thermostatically controlled to maintain an engine temperature of 25 deg C at the low end of the ambient temperature range specified in "Environmental Conditions" Paragraph above.

F. Governor
1. Type: Adjustable isochronous type, with speed sensing.

G. Engine Cooling System

1. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pumping.
2. Radiator: Rated for specified coolant.
3. Coolant: Solution of 50 percent ethylene glycol and 50 percent water.
4. Expansion Tank: Constructed of welded steel plate and equipped with gage glass and petcock. Capacity is as indicated.
5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer. Features include the following:
    a. Thermostatic Elements: Interchangeable and nonadjustable.
    b. Actuator Design: Normally open valves to return to open position when actuator fails.
6. Coolant Hose: Flexible assembly with nonporous rubber inside surface and aging, ultraviolet, and abrasion-resistant fabric outer covering.
    a. Rating: 50-psig (345-kPa) maximum working pressure with 180 deg F (82 deg C) coolant, and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Fuel Supply System
1. Comply with NFPA 30 and NFPA 37.
2. Base-Mounted Fuel Oil Tank: Factory-installed and -piped, listed and labeled fuel oil tank. Features include the following:
    a. Tank level indicator.
    b. Capacity: Fuel for 24 hours of continuous operation at 100 percent rated power output.
    c. Vandal-resistant fill cap.

I. Engine Exhaust System
1. Muffler: Critical type, sized as recommended by engine manufacturer. Measured sound level, according to the Diesel Engine Manufacturers Association's "DEMA Test Code for the Measurement of Sound from Heavy-Duty Reciprocating Engines" at a distance of 10 feet from the exhaust discharge, is 85 dBA or less.
2. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to muffler drain outlet through a petcock.
3. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.
4. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.
5. Exhaust Piping External to Engine: ASTM A 53, Schedule 40, welded, black steel, with welded joints and fittings.
6. Thimbles for Exhaust Piping: Comply with NFPA 211.

J. Starting System
1. Description: 12-V electric, with negative ground and including the following items:
    a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph above.
    b. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
    c. Cranking Cycle: As required by NFPA 110 for system level specified.
    d. Battery complies with SAE J537 and has adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph above to provide specified cranking cycle at least twice without recharging.
    e. Battery Cable: Size as recommended by generator set manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

f. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit complies with UL 508 and includes the following features:
   1) Operation: Equalizing-charging rate of 10 A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until battery is discharged again.
   2) Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   3) Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.
   4) Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.
   5) Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either of these conditions closes contacts that provide a battery charger malfunction indication at system control and monitoring panel.
   6) Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

K. Control And Monitoring
1. Functional Description: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic-transfer switches initiate starting and stopping of the generator set. When the generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.
2. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages are grouped on a common control and monitoring panel mounted on the generator set. Mounting method isolates the control panel from generator-set vibration.
3. Indicating and Protective Devices, and Controls: Include those required by NFPA 110 for a Level 1 system, plus the following:
4. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
5. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data link transmission of indications to remote data terminals. Data system connections to terminals are covered in another Section.
6. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Locate audible device and silencing means where indicated.
   a. Engine high-temperature shutdown.
   b. Lube-oil low-pressure shutdown.
   c. Overspeed shutdown.
   d. Remote emergency-stop shutdown.
   e. Engine high-temperature prealarm.
   f. Lube-oil low-pressure prealarm.
   g. Fuel tank low level.
   h. Overcrank shutdown.
   i. Coolant low-temperature alarm.
   j. Control switch not in auto position.
   k. Battery-charger malfunction alarm.

l. Battery low-voltage alarm.

7. Remote Emergency-Stop Switch: Flush wall-mounted, unless otherwise indicated and prominently labeled. Push button is protected from accidental operation.

L. Generator, Exciter, And Voltage Regulator
1. Comply with NEMA MG 1 and specified performance requirements.
2. Drive: Generator shaft is directly connected to engine shaft. Exciter is rotated integrally with generator rotor.
3. Electrical Insulation: Class H or Class F.
4. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
5. Construction prevents mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
6. Excitation uses no slip or collector rings, or brushes, and is arranged to sustain generator output under short-circuit conditions as specified.
7. Enclosure: Dripproof.
8. Instrument Transformers: Mounted within generator enclosure.
9. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   a. Adjusting rheostat on control and monitoring panel provides plus or minus 5 percent adjustment of output voltage operating band.
10. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
11. Subtransient Reactance: 12 percent, maximum.

M. Source Quality Control
1. Factory Tests: Include prototype testing and Project-specific equipment testing (testing of equipment manufactured specifically for this Project).
2. Prototype Testing: Performed on a separate engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   a. Tests: Conform to those required for Level 1 energy converters in paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110.
   b. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype have been tested to demonstrate compatibility and reliability.
3. Project-Specific Equipment Tests: Factory test engine generator set and other system components and accessories before shipment. Test items individually and assembled and connected as a complete system the same as specified in "Field Quality Control" Article below. Record and report test data. Conform to the following:
   a. Test Equipment: Use instruments calibrated within the previous 12 months and with accuracy directly traceable to the National Institute of Standards and Technology.
   b. Hydrostatic Test: Perform on radiator, heat exchanger, and engine water jacket.
   c. Generator Tests: Comply with IEEE 115.
   d. Complete-System, Continuous-Operation Test: Include nonstop operation for a minimum of 8 hours, including at least 1 hour each at one-half, three-fourths, and full load, and 2 hours at 110 percent of full load. If unit stops during the 8-hour test, repeat the complete test. Record the following minimum data at start and end of each load run, at 15-minute intervals between those times, and at 15-minute intervals during balance of test:
      1) Fuel consumption.
      2) Exhaust temperature.
      3) Jacket water temperature.
      4) Lubricating oil temperature and pressure.
      5) Generator load current and voltage, each phase.

6) Generator system gross and net output kW.

e. Complete-System Performance Tests: Include the following to demonstrate conformance to specified performance requirements:
   1) Single-step load pickup.
   2) Transient and steady-state governing.
   3) Transient and steady-state voltage performance.
   4) Safety shutdown devices.

f. Observation of Test: Provide 14 days' advance notice of tests and opportunity for observation of test by Owner's representatives.

g. Report test results within 10 days of completion of test.

2.7 TRANSFER SWITCHES

A. General: The project requires one ATS's (Automatic Transfer Switch). The ATS (Amperage as indicated on plans) shall be a 4-Pole unit required to transfer within 10 seconds after loss of power. The ATS will include the engine generator exerciser unit. The passenger elevators will receive a signal from the ATS's that the system is running on generator power and initiate the emergency mode operation allowing only one elevator per bank to operate; the fire department shall have control via fire department key switch. The transfer switches shall be monitored and controlled locally and only one remote ATS annunciator will be provided. Transfer switches will be required to interface with elevator controllers, fire alarm system and building management system.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
   1. Conventional Transfer Switches:
      a. Automatic Switch Co.
      b. Russelectric, Inc.
      c. Zenith, General Electric Co.

C. General Transfer-Switch Product Requirements
   1. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated based on testing according to UL 1008.
   2. Annunciation and Control Interface Components: Devices at transfer switches for communicating with remote annunciators or annunciator and control panels have communications capability matched with the remote device.
   3. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 deg C to 70 deg C.
   4. Resistance to Damage by Voltage Transients: Components meet or exceed voltage-surge withstand capability requirements when tested according to ANSI C37.90.1. Components meet or exceed voltage-impulse withstand test of NEMA ICS 1.
   5. Four-Pole Switches: Where 4-pole switches are indicated, provide neutral switching.
   6. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6; UL 508, unless otherwise indicated.
   7. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
      a. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
      b. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
      c. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   8. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions.

9. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
    a. Limitation: Switches using molded-case switch or insulated-case circuit-breaker components and switches using contactors not designed for continuous-duty repetitive switching between active power sources are not acceptable.
    b. Switch Action: Double throw; mechanically held in both directions.
    c. Switch Contacts: Silver composition for load current switching. Conventional automatic transfer-switch units rated 225 A and greater have separate arcing contacts.

D. Automatic Transfer Switch
1. Comply with Level 1 equipment according to NFPA 110.
2. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
3. Manual Switch Operation: Manually operated under load, with the door closed, and with either or both sources energized. Transfer time is the same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
4. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
5. Digital Communications Interface: Full-duplex RS 422 type, matched to capability of remote annunciator or annunciator and control panel.
6. Transfer Switches Based on Molded-Case Switch Components: Comply with UL 489, UL 869, and NEMA AB 1.

E. Automatic Transfer-Switch Features
1. Voltage sensing for each phase of normal source. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable 0 to 6 seconds and factory set at 1 second.
3. Voltage/Frequency Lockout Relay: Prevents premature transfer to an emergency generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set to pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set to pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes and factory set at 10 minutes. Provides automatic defeat of the delay on loss of voltage or sustained undervoltage of the emergency source, provided normal supply has been restored.
5. Test Switch: Simulates normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via the transfer-switch, normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: 2 normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240 V, ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of the condition of the normal source. A pilot light indicates override status.
10. Engine Starting Contacts: 1 isolated, normally closed and 1 isolated, normally open. Contacts are gold flashed or gold plated and rated 10 A at 32 V, dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from 0 to 5 minutes; factory set at 5 minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory-set periods are for 7 days, 20 minutes, and 5 minutes, respectively. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection between exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

F. Remote Annunciator System
1. Functional Description: Remote annunciator panel annunciates conditions at indicated transfer switches. Annunciation includes the following:
    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of digital communications link.
2. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group indicating the transfer switch it monitors, location of switch, and identity of load it serves.
    c. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
    d. Lamp Test: Push-to-test or lamp test switch on front panel.

G. Finishes
1. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

H. Source Quality Control
1. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1

2.8 TOUCHUP PAINT

A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.

B. For Nonequipment Surfaces: Matching type and color of undamaged, existing adjacent finish.

PART 3 - INSTALLATION

3.1 EXAMINATION

A. Verify that field measurements and circulating arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition Drawings are based on casual field observation and existing record documents. Contractor shall report discrepancies to Owner and Architect/Engineer before disturbing existing installation.

D. The start demolition is verification that the contractor accepts and thoroughly understands existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment, feeders or branch circuits, use personnel experienced in such operations.

C. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from or notify Owner and Architect/Engineer at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Accessible Work Indicated to Be Demolished: Remove exposed electrical installation in its entirety.

B. Abandoned Work: Cut and remove buried raceway 2 inches below the surface of adjacent construction. Remove existing wiring in its entirety. Cap and patch surface to match existing finish.

C. Removal: Contractor (Division 26) shall be responsible to disconnect, make safe and lower to the ground all electrical systems, equipment, materials and components indicated for removal or demolition. Electrical conduit and conductors, feeders and branch circuits for all electrical systems indicated on the drawings and in the specifications shall be removed in their entirety unless otherwise indicated. The demolished material shall be collected and removed from the project site by the Demolition or General Contractor.

D. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation or labeled existing to be maintained.

E. Remove, relocate, and extend existing installations to accommodate the construction process, phasing and the temporary partitions utilized to segregate the construction areas from occupied areas.

F. Where electrical work to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

G. Repair adjacent construction and finishes damaged during demolition and extension work.

H. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

I. Extend existing installations using materials and methods compatible with existing electrical installations or as specified.

3.4 CLEANING AND REPAIR OF EXISTING EQUIPMENT

A. Clean and repair existing materials and equipment indicated as, existing to be maintained or existing to be relocated.

3.5 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

3.6 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications, drawings, elevations and shop drawings in Divisions 2 through 16 to verify rough-in requirements.

3.7 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
   1. Coordinate electrical systems, equipment, and materials installation with other building components.
   2. Verify all dimensions by field measurements.
   3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
   4. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
   5. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   6. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
   7. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
   8. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
   9. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.8 ELECTRICAL SUPPORTING METHODS

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Conform to manufacturer's recommendations for selecting supports.

D. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200-lb-minimum design load.

3.9 INSTALLATION OF ELECTRICAL SUPPORTING DEVICES

A. Install devices to securely and permanently fasten and support electrical components.

B. Raceway Supports: Comply with NFPA 70 and the following requirements:
1. Conform to manufacturer's recommendations for selecting and installing supports.
2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
3. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.
5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.
6. Hanger Rods: 1/4-inch diameter or larger threaded steel, except as otherwise indicated.
7. 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.

C. In open overhead spaces, cast boxes threaded to raceways need not be separately supported, 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 raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

D. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:
1. Fasten by means of machine screws, welded threaded studs, or spring-tension clamps on steel.
2. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.

3.10 INSTALLATION OF CONDUCTORS AND CABLES

A. Examination
1. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Wire and Insulation Applications
1. Feeders: Type THHN/THWN, in raceway.
2. Branch Circuits:
   a. General: Type THHN/THWN, copper conductor, in raceway.
3. Class 1 Control Circuits: Type THHN/THWN, in raceway.
4. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

5. Class 2 Control Circuits: Type THHN/THWN, in raceway.

C. Installation
1. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
2. Minimum conductor size shall be #12AWG.
3. Remove existing wires from raceway before pulling in new wires and cables.
4. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
5. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
6. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
7. Support cables according to Division 26 Section "Raceway Support Systems."
8. Seal around cables penetrating fire-rated elements according to Division 7 Section "Firestopping."
9. Identify wires and cables according to Division 26 Section "Electrical Identification."

D. Connections
1. Conductor Splices: Keep to minimum.
2. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
3. Use splice and tap connectors compatible with conductor material.
4. Use oxide inhibitor in each splice and tap connector for aluminum conductors.
5. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.
6. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
7. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Field Quality Control
1. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
2. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
3. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.11 INSTALLATION OF RACEWAYS AND BOXES

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

B. Wiring Methods
1. Indoors: Use the following wiring methods:
   a. Exposed: EMT.
   b. Concealed: EMT.
   c. Connection to Vibrating Equipment (Including Transformers, Generators and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC in dry locations; All wet or damp locations shall use LFMC. Wet locations shall include,

but not be limited to; mechanical rooms, equipment room or vehicle washing areas.

d. Damp or Wet Locations: Rigid steel conduit (RMC).

e. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

1) Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. Installation

1. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
2. Minimum Raceway Size: 3/4-inch trade size.
3. Minimum Raceway Size: 3/4-inch trade size.
4. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
5. Install raceways level and square and at proper elevations. Provide adequate headroom.
6. Complete raceway installation before starting conductor installation.
7. Support raceways as specified in Division 26.
8. Use temporary closures to prevent foreign matter from entering raceways.
9. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
10. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
11. Junction and Pull Boxes:
    a. Junction and outlet boxes located above accessible ceilings shall be accessible after final installation of all electrical and other trades work. Boxes shall be located within 18” of suspended ceilings.
    b. Boxes for branch circuit homeruns shall be located above accessible ceiling. Branch circuit homeruns from in wall, or otherwise concealed, outlet or junction boxes shall not be permitted.
12. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
    a. Run parallel or banked raceways together, on common supports where practical.
    b. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
13. Join raceways with fittings designed and approved for the purpose and make joints tight.
    a. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
    b. Use insulating bushings to protect conductors.
14. Tighten set screws of threadless fittings with suitable tools.
15. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
16. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
17. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
18. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

19. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.
    a. Select each surface raceway outlet box, to which a lighting fixture is attached, of sufficient diameter to provide a seat for the fixture canopy.
20. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

D. Protection
1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
    a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

E. Cleaning
1. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

F. Field Quality Control
1. Testing: On installation of medium-voltage cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
    a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.2. Certify compliance with test parameters.
2. Correct malfunctioning cables and accessories at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

G. Protection
1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to prevent entrance of moisture into the cables and to ensure medium-voltage cables are without damage or deterioration at the time of Substantial Completion.

3.12 INSTALLATION OF ELECTRICAL IDENTIFICATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

F. Install Circuit Identification Labels on Boxes: Label externally as follows:
1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

G. Color-Code Conductors: Secondary service, feeder, and branch circuit conductors throughout the secondary electrical system.
   1. 480/277-V System: As follows:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Gray.
      e. Ground: Green.

   2. 208/120-V System: As follows:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Neutral: White.
      e. Ground: Green.

   3. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
      a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
      b. Colored cable ties applied in groups of 3 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 to a snug fit, and cut off excess length.

H. Junction and Outlet Boxes: Use permanent marker in a neat and legible manner to label the box/cover with the panel name and circuit number of the branch circuit(s) contained within. Junction boxes for feeders shall be provided with nameplates as identified in sections below.

I. Apply identification to conductors as follows:
   1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
   2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
   3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

J. Apply warning, caution, and instruction signs and stencils as follows:
   1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of 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, and other emergency operations.

K. Install identification as follows:
   1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication,

signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1-1/2-inch- high label; where 2 lines of text are required, use lettering 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.

a. Electrical cabinets, and enclosures.
b. Push-button stations.
c. Power transfer equipment.
d. Contactors.
e. Control devices.
f. Power-generating units.

3.13 INSTALLATION OF GROUNDING SYSTEMS

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Application
1. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
   a. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
      1) Feeders and branch circuits.
      2) Receptacle circuits.
      3) Flexible raceway runs.

D. Connections
1. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   a. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
   b. Make connections with clean, bare metal at points of contact.
   c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   d. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
2. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
3. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
4. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

5. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.14 INSTALLATION OF PACKAGED ENGINE GENERATOR

A. Provide anchorage according to manufacturer's written instructions, unless otherwise indicated.

B. Maintain minimum workspace around components according to manufacturer's Shop Drawings and National Electrical Code.

C. Identification
1. Identify system components according to Division 26 Section "Electrical Identification."

D. Field Quality Control
1. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise installation and connection of unit and to report results in writing.
2. Supervised Adjusting and Pretesting: Under supervision of factory-authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Load system using a variable resistive and reactive load bank simulating kW, and power factor of loads for which unit is rated.
3. Tests: Engage a factory-authorized service representative to perform tests on completion of installation of system. Use instruments bearing records of calibration within the last 12 months, traceable to National Institute for Standards and Technology standards, and adequate for making positive observation of test results. Include the following:
    a. National Electrical Testing Association Tests: Perform each visual and mechanical inspection and electrical and mechanical test stated in InterNational Electrical Testing Association's NETA ATS for emergency engine generator sets. Certify compliance with test parameters.
    b. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
    c. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
    d. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
    e. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
4. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

E. Cleaning
1. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

F. Demonstration

1. Training: Engage a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's maintenance personnel as specified below.
   a. Conduct a minimum of 4 hours of training as specified in Division 01 Section "Contract Closeout."
   b. Schedule training with at least 7 days' advance notice.

G. Commissioning
1. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

3.15 INSTALLATION OF TRANSFER SWITCH

A. Wall Mounting of Switches:
1. Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
2. Equipment mounted on sheetrock and studded walls shall not be attached directly to the sheetrock wall. Provide ½" plywood attached to wall studs or provide metal channel attached to wall studs for mounting of equipment.
3. Equipment without walls for attachment shall be mounted on freestanding metal channel supports. Supports shall me requirements defined by seismic and attachment submittal (by licensed structural engineer), and shall not utilize other trades equipment or supports to assist in supporting the electrical equipment.

B. Annunciator Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Division 26 Section "Electrical Identification."

D. Wiring To Remote Components
1. Match type and number of cables and conductors to control and communications requirements of transfer switches used. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

E. Connections
1. Ground equipment as indicated and required by National Electrical Code.
   a. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Field Quality Control
1. Preliminary Tests: Perform electrical tests as recommended by manufacturer and as follows:
   a. Measure phase-to-phase and phase-to-ground insulation resistance levels with insulation resistance tester. Include external annunciator and control circuits. Use test voltages and procedure recommended by manufacturer. Meet manufacturer's specified minimum resistance.
   b. Check for electrical continuity of circuits and for short circuits.
2. Field Tests: Give 7 days' advance notice of tests and perform tests in presence of Owner's representative.
3. Coordinate tests with tests of generator plant and run them concurrently.
4. Tests: As recommended by manufacturer and as follows:
   a. Contact Resistance Test: Measure resistance of power contacts for automatic transfer switches, non-automatic transfer switches, and bypass/isolation switches.

Resolve values in excess of 500 micro-ohms and differences between adjacent poles exceeding 50 percent.

b. Operational Tests: Demonstrate interlocking sequence and operational function for each switch at least 3 times.
   1) Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   2) Simulate low phase-to-ground voltage for each phase of normal source to automatic transfer switches.
   3) Verify time-delay settings and pickup and dropout voltages.

5. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify that equipment meets specified requirements.
6. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected items. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. Demonstration
1. Training: Engage a factory-authorized service representative to instruct Owner's personnel in the operation, maintenance, and adjustment of transfer switches and related equipment. Provide a minimum of 4 hours of instruction scheduled 7 days in advance.

3.16 TOUCHUP PAINTING

A. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

END OF DIVISION 26