SECTION 26 05 01 - ELECTRICAL GENERAL PROVISIONS

PART 1 -GENERAL

1.1 RELATED DOCUMENTS

A. The Drawings and General Provisions of the Contract, including, but not limited to General and Supplementary Conditions and Division 1 Specification Sections apply to all the work specified in this Division and its sections.

B. This Division is a part of the entire set of Contract Documents and shall be coordinated with the applicable provisions of the other parts. The following requirements clarify, amend or are in addition to the requirements set forth under the General Conditions and Division 1.

C. In case of any discrepancy between the various Drawings, or between parts of the Specifications or between Drawings and Specifications, the matter shall immediately be submitted to the Engineer and for Contractual purposes the most expensive condition shall apply.

1.2 INTENT

A. It is the intention of the Specification and Drawings to call for finished work, tested and ready for operation.

B. Any apparatus, material, incidental accessories or work not shown on the Drawings or itemized in the Specification, but reasonably implied and necessary to make the Work complete and perfect in all respects and ready for operation, shall be provided by the Contractor without additional expense to the Owner.

C. Major items of equipment are specified on the Drawings or in the Specifications and shall be furnished complete with all accessories normally supplied.

D. Minor details not shown nor specified, but necessary for the proper installation and operation, shall be included in the Work and in the Contractor's estimate, the same as if herein specified.

E. With submission of bid, Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that the Contractor has included the cost of all required items in his proposal.

1.3 DEFINITIONS

A. "Engineer" is the person lawfully licensed to practice engineering or an entity lawfully practicing engineering as identified as such in the Agreement or by the Architect and is referred to throughout the Contract Documents as if singular in number. The term "Engineer" means the Engineer or the Engineer's authorized representative.

B. "Furnish" means to supply and deliver to the project site or appropriate trade.

C. "Install" means to unpack, assemble, erect, fit up and connect in the specified or appropriate manner so as to be complete and ready for intended use.

D. "Provide" means to furnish and install.

1.4 DRAWINGS

A. Drawings issued with these specifications are diagrammatic and indicate the general arrangement of systems and approximate location of apparatus to be provided. Exact locations of all equipment are to be coordinated by the Contractor and are subject to approval of the Architect, Engineer and Owner.

B. The general runs of raceways, feeders, branch circuits, etc., are indicated on the drawings. It is not intended that the exact routing of these items be determined there from. Check drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, the Architect/Engineer shall be notified before proceeding with installation.

C. The locations of lighting fixtures, outlets, panels and other equipment indicated on the drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in order to meet field conditions or to simplify the work. The Contractor shall verify that all minimum clearance distance and access requirements are met.

D. Dimensions given on the Drawings govern scale measurements, and large scale Drawings govern small scale Drawings; omissions on large scale Drawings do not govern small scale Drawings unless the omission is noted on the large scale Drawings.

E. Circuit "tags" in the form of arrows are used to indicate the home runs of conduit to electrical distribution panels and switchboards. These tags show the circuits in each home run, the number of each circuit and the panel designation. It is not intended that these numbers be followed in connecting the circuits at the panelboards. Circuits shall be connected so that the loads, on each phase, are equal with maximum allowable deviations of 10% between phases. Show the actual circuit numbers on the finished record drawings, and panel directories.

F. The drawings generally do not indicate the exact number of wires in each conduit for the branch circuit wiring of fixtures and outlets. Provide the correct wire size and quantity as required by the indicated circuiting, manufacturer's installation instructions, control wiring diagrams, and or manufacturer's instructions, if any, specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.

G. Where two or three branch circuits are run in a common conduit, it shall be understood that these circuits are of different phases. Where circuits serve office outlets or lighting circuits with electronic ballasts, they shall NOT use a common neutral wire. Where common neutrals are allowed, no more that three circuits with one common neutral wire are to be installed in any branch circuit home run conduit unless specifically indicated otherwise.

H. The Contractor shall take special care in the installation of raceways where same is concealed to ensure that it does not project beyond the finish lines of floors, ceilings and walls.

I. If directed by the Engineer, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades for proper execution of the work.

J. The Owner reserves the right to make reasonable changes before installation of equipment, without additional cost.

1.5 INSPECTION OF SITE

A. The Contractor and all Subcontractors as necessary shall visit the site, examine and verify the conditions under which the work must be conducted before submitting a proposal.

B. The submission of a Proposal implies that the Contractor and all Subcontractors as necessary have visited the site and are familiar with the conditions under which the work must be conducted.

1.6 WORK INVOLVING OTHER TRADES

A. The Contractor is responsible for compliance with all local, state and federal licensing regulations, union jurisdictions, labor laws, etc., and shall engage qualified and licensed individuals to perform all aspects of the Work.

B. The Contractor shall to refer to architectural, structural, plumbing, mechanical, process and instrumentation, and other drawings and sections that indicate the type of construction and equipment with which the work of this section must be coordinated.

C. The Electrical Contractor shall coordinate the installation of equipment, and raceways with the work of all other trades.

1.7 CODES, PERMITS & FEES

A. The Contractor shall give all necessary notice, apply for all permits, and pay all governmental taxes, fees and other costs in connection with his work; file all necessary plans, all documents and obtain all necessary approvals from state and local departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the Owner with copies to the Architect and Engineer

before request for acceptance and final payment for the Work.

B. All work shall be executed in accordance with the rules and regulations set forth in local, state and federal codes and the requirements of the local utility companies. Where the Drawings or Specifications indicate materials or construction in excess of code requirements, the Drawings or Specifications shall govern.

PART 2 -PRODUCTS

2.1 MATERIALS & WORKMANSHIP

A. All equipment and materials shall be new and in unblemished condition and shall be standard products of manufacturers regularly engaged in the production of electrical equipment.

B. All equipment shall be UL listed and labeled and shall conform to the latest edition of the NEC.

C. All material shall conform to the requirements of all applicable codes and shall be trademarked and/or grademarked.

D. All major items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete, properly operating system.

E. The drawing arrangements are based on the manufacturers listed, either in these specifications or on the schedules on the Drawings.

F. If any other equipment is considered for approval it shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the Drawings and/or specified and shall be compatible with the other components of the system.

G. At the time of system starting and testing, the Contractor shall be responsible to have a factory authorized service representative of the manufacturer present for the equipment listed herein. All required additions or alterations for proper equipment operation and performance shall be provided at no additional cost to the Owner.

2.2 DEVIATIONS

A. The Drawings and/or Specifications indicate the name, model number or type of equipment or materials to be used as a standard for the materials specified.

B. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign, new drawings shall be prepared at his own expense after approval of the substitution is granted.

C. Where such approved deviations require a different quantity and arrangement of raceways, supports, wiring, conduit and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such raceways, structural supports, insulation, controllers, motors, starters, electrical wiring and conduits, or any other additional equipment required by the system at no additional cost to the Owner for this and any other trade affected by the change.

D. Whether expressly specified or otherwise noted, no materials, products or equipment shall be incorporated in the new work without written approval.

E. A satisfactory review of a submittal by the Engineer shall not be construed as an acceptance of a deviation unless that deviation is flagged as a deviation by the Contractor on the submittal.

F. In cases where more than one manufacturer, material or product is specified by name, the Contractor has the option to use any one named, but he must notify the Engineer of his choice on the proposed submittal schedule.

G. In cases where a single manufacturer, material, or product is specified with the words "or approved equal", or words of similar intent, the Contractor must prove to the Engineer's satisfaction that the material or product proposed is essentially equal in quality, design, capacity, size, availability, durability or other criteria to that specified. A complete installation of the proposed substitution shall have been in satisfactory use for a sufficient period of time to establish its value as equal.

H. The Engineer shall have the final authority as to the acceptance of any substitutions. Any claims by the Contractor for extension of time or increase in cost as a result of such substitutions will not be accepted.

2.3 SUBMITTALS

A. The materials, workmanship, design and arrangement of all work installed under the Contract shall be subject to the approval of the Engineer.

B. Submittals shall bear stamped evidence of checking by the Contractor when submitted to the Engineer's office.

C. The Engineer will examine all shop drawings and samples and will return same with the status of submission indicated with one of the following notations:
   1. NO EXCEPTIONS TAKEN
   2. MAKE CORRECTIONS NOTED
   3. REVISE & RESUBMIT
   4. REJECTED - SEE REMARKS

D. Corrections or Comments made on the Shop Drawings during this review do not relieve Contractor from compliance with requirements of the Drawings and Specifications. This check is only for review of general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimension, selecting fabrication, processes and techniques of construction, coordinating his work with that of all other trades and performing his work in a safe and satisfactory manner.

E. Review by the Engineer shall not relieve the Contractor from responsibility of errors, deviation from Contract Documents or violation of sound practices.

F. Should changes be indicated on the returned submittals, the Contractor shall provide revised submittals promptly until final acceptance by the Engineer. Any subsequent changes made to the submittals after initial review by the Engineer shall be indicated as such by the Contractor.

G. Upon final acceptance of the submittals, the Contractor shall distribute copies as required for proper coordination or as directed by the Engineer.

H. The Contractor shall keep one copy of each approved submittal in the field office at all times.

I. Contractor shall distribute reviewed shop drawings to all other trades to assure proper coordination.

J. The Contractor shall provide additional shop fabrication and field installation shop drawings as required by the Engineer during construction.

K. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

L. Product Data General: Submit manufacturer’s product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
   1. Product Data: Provide information for each type of product specified.

M. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work to describe the work.
   1. Manufacturer to propose spacing and layout of supporting devices including heights, spacing, and frequency.

N. Samples: For each exposed product and for each color and texture specified.

O. Maintenance data.

P. Warranties: Sample of special warranties.

Q. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

R. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:

1. Requirements of 017700 CLOSEOUT PROCEDURES.
2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

2.4 QUALITY ASSURANCE

A. General:
   1. Comply with the requirements of Section 014000, Quality Requirements.

B. Regulatory Requirements:
   1. Perform all electrical work in conformance with the requirements of NFPA 70, the National Electrical Code, as adopted an amended by the New Jersey Uniform Construction Code (NJUCC).

C. Certifications:
   1. Submit evidence with all Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements. Products shall be listed and labeled by Underwriter's Laboratory (UL), approved by Factory Mutual (FM) or certified as meeting the listing standards by the Electrical Testing Laboratory (ETL).
      a. Such evidence may consist of either a printed mark on the data or a separate listing card.

2.5 INDIVIDUAL MOTOR STARTERS

A. Where electrical disconnect switches, motor starters, variable frequency drives and the like are identified on the Contract Drawings as 'Furnished With Equipment' (FWE) the contractor shall install (mount and wire) these devices which are procured by others.

B. Mechanical Contractor shall furnish and turn over motor starting equipment for motors provided as part of his work to the Electrical Contractor, who shall erect and provide power wiring for same.

C. The Electrical Contractor shall install all starting equipment except starters specified to be factory mounted and wired as part of the equipment, and shall do all wiring necessary to supply power to the starter, including connections from the starters to the motors.

D. Electrical contractor shall provide all motor safety switches, local disconnects, motor starters, and drives unless otherwise noted as furnished with equipment (FWE).

2.6 FIRESTOPPING

A. Wall penetrations shall be sealed with 3M Brand firestop materials (Moldable Putty, FS-195 strip, CS-195 sheet) in accordance with the manufacturer's recommendations. Obtain approval for each type of penetration and firestop method before proceeding.

B. Floor and roof penetrations shall be similarly sealed, and furthermore shall be dammed and filled to assure the opening and the sleeve are watertight. Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

2.7 TEMPORARY POWER

A. Electrical Contractor shall provide temporary lighting and power for construction.

B. Temporary power circuits for small hand tools shall be GFIC protected.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which all products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any

conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 SAFETY

A. In accordance with generally accepted construction practices and in particular Federal Regulation Part 1926, Subpart K and Subpart S (Occupational Safety and Health Act), latest edition (OSHA), the Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours.

3.3 SCHEDULING OF WORK

A. Carefully examine the Drawings and Specifications, visit the site, and be fully informed as to all existing conditions, dimensions and limitations before starting the work.

B. Once work is started, the Contractor shall complete the work without interruptions so as to return work areas to the Owner as soon as possible.

C. The Contractor shall adequately protect and preserve all existing and newly installed work. Any damage to facilities shall be promptly repaired by the Contractor at his expense.

D. Covering Work: No raceways, conductors, fittings, outlets or other work of any kind shall be covered up or hidden from view before it has been examined or approved by the Engineer and any authority having jurisdiction over same. Any imperfect work or material which may be discovered shall be removed and corrected immediately after being rejected.

E. The Contractor shall consult with the Owner as to the methods of carrying on the work so as not to interfere with the owner's operation any more than absolutely necessary; accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such times as will be designated by the Owner.

F. The Contractor shall take all necessary precautions to protect the Owner's equipment and personnel from damage or injury due to his carrying on of the work. The area in which the Contractor is working must be kept as clean as possible at all times, with only a minimum amount of construction material at the site at one time.

G. Materials and equipment must be placed to avoid interferences with the Owner's operation and shall be moved when directed by the Owner.

3.4 COORDINATION

A. Prior to installation of any electrical equipment, the contractor shall prepare coordination shop drawings showing the proposed layout of equipment in each electrical room and data equipment room. Layout drawings shall be to scale and be dimensioned showing actual equipment sizing as indicated on the approved equipment submittals and indicate proper clearances.

B. Electrical contractor shall review drawings and specifications of all other divisions at time of bid, and include in their quote all power connection to equipment and devices that may or may not be represented on the Division 26 drawing.

C. Before any work is installed, and before any equipment is fabricated or purchased, the Electrical Contractor shall carefully check the Contract Drawings of all divisions, and all job conditions. Any lack of coordination between the Work and the Drawings or job conditions shall be immediately reported to the Engineer in writing.

D. Field Measurements: Verify the dimensions governing the work at the site. No extra compensation shall be claimed or will be allowed on account of differences between actual dimensions and those indicated

on the Drawings.

E. Examine adjoining work on which this work is dependent and report any work which must be corrected. No waiver of responsibility for defective work shall be claimed or will be allowed due to the failure to report unfavorable conditions affecting this work.

F. Exact locations of all equipment are to be coordinated by the Contractor and are subject to approval of the Architect, Engineer and the Owner.

G. Generally, all work shall be installed so as to be readily accessible for operation, maintenance and repair. Such spaces and clearances shall, however, be kept to the minimum size required.

H. Any rearrangement of light fixtures, conduits, panels or other such departures from the Drawings and the reasons thereof, shall be submitted to the Engineer for approval, in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior approval of the Engineer.

I. Conduit and boxes located within masonry walls shall be carefully laid out and coordinated with the work of other trades. Certain masonry partitions are to be filled solid. Refer to wall types indicated on Architectural plans, and make all necessary allowances.

3.5 COOPERATION

A. The Contractor shall confer with the various trades engaged in the construction of the building and arrange all parts of conduits, panels, and equipment, etc., with the building construction and the architectural finish so that it will harmonize in service and appearance.

B. The Contractor shall give full cooperation to the various trades and shall furnish in writing, with copies to the Architect and Engineer, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference and delay.

3.6 PROTECTION OF PROPERTY

A. In all occupied buildings, the Contractors shall be responsible for performing the work in a manner that will not affect the building operation or harm existing equipment.

B. Special attention and care shall be employed when working near or adjacent to computer rooms, telephone equipment rooms, and other sensitive areas. This includes dust or dirt contamination, temperature or humidity fluctuations, noxious odors, disturbing noise or other disruptive conditions.

C. Restore to its original condition, without expense to the Owner, any of the Owner's property that shall become damaged due to the negligence and/or work of the Contractor's employees or subcontractors.

3.7 REMOVALS

A. In general, removal work is indicated on the Drawings. This shall include all items such as, but not limited to existing light fixtures, panels, conduits, supports and equipment where such items are not required for the proper operation of the revised system.

B. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse.

C. Materials to be removed shall become the property of the Contractor. These materials shall be legally disposed of by the Contractor.

D. Work that has been cut or partially removed shall be protected against damage until covered by permanent construction.

3.8 INTERRUPTIONS

A. Where new work is to be connected to existing systems or equipment, the work shall be installed so as to minimize downtime or disruption of services. The Contractor shall schedule the work as directed by the Owner.

B. Where temporary shutdown of essential services are required (i.e. fire alarm) the Contractor shall make allowance for the restoration of the service at the end of each workday.

3.9 CUTTING AND PATCHING

A. All cutting, patching and repair work caused by Contractor shall be the Contractors responsibility and shall be done by personnel skilled in the trade of the repair work. All such repairs shall be subject to the approval of the Engineer and Owner.

3.10 WALL, FLOOR AND ROOF PENETRATIONS

A. Penetrations at building walls, partitions, floors and roofs shall be located in the field by the Contractor, and are subject to approval by the Engineer.

B. Where holes in masonry construction are not pre-set, the Contractor requiring the hole shall be responsible for cutting it by core drilling, saw cutting or other suitable method. Provide a minimum of 1/4" clearance between conduit and wall sleeves.

3.11 MANUFACTURER'S DIRECTIONS

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Engineer who shall resolve the conflict as required to meet the conditions of the project.

3.12 MAINTENANCE AND PROTECTION

A. The Contractor shall be responsible for work and equipment until finally inspected, tested and accepted.

B. Equipment and materials shall be protected from theft, injury or damage.

C. Protect equipment outlets, conductors, conduit openings, etc. with temporary plugs or caps.

D. Provide adequate storage for all equipment and materials delivered to the job site. Equipment set in place in unprotected areas must be provided with temporary protection.

E. Batteries for equipment such as UPS, back-up power supplies,and generator start batteries shall be maintained, and properly charged per manufacturer’s instructions until the associated equipment is installed, and the batteries are maintained through the normal operation of the equipment.

3.13 RECORDING CHANGES

A. During construction, keep a record on a clean set of prints of all deviations and changes in the Work shown on the Contract Drawings. Record these deviations and changes daily as they occur. Actual locations of equipment, panels and routes of conduit, etc., as installed, shall be readily transferred to the final Record Drawings. This set of prints shall be available at all times for the Architect's or Engineer's inspection.

3.14 CLEANING

A. Remove rubbish and surplus materials from the job site each day and leave premises and work in a clean condition.

3.15 TESTS

A. Conduct all tests and adjustments of equipment as specified or necessary to verify performance requirements of as required by authorities having jurisdiction. Submit data taken during such tests to Architect. Pay all fees involved in required testing of equipment. Refer to appropriate Sections for required tests.

3.16 OPERATION AND MAINTENANCE MANUALS

A. Prepare and provide to the owner a minimum of Three (3) binders containing information on all equipment provided under this contract. Furnish all installation, operation and maintenance booklets, parts lists, and information regarding warrantees and service. Where literature is generic or applies to more than one product, it shall be marked to indicate which parts are applicable.

3.17 TRAINING

A. Provide a minimum of Four (4) hours of training to the Owner's maintenance personnel in the operation of all equipment indicated in specific Sections of Division 260000, provide the services of a manufacturer’s authorized representative to instruct the Owner in the operation and maintenance of the equipment.

END OF SECTION 26 05 01

SECTION 26 05 03 - ELECTRICAL RELATED WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General Conditions, Supplementary General Conditions, Division 1 General Requirements, and Special Conditions for Electrical work apply to all the work specified in each Section of Division 16 - Electrical Work

1.2 DESCRIPTION OF WORK

A. Work under this Contract consists of providing all labor, materials, and services necessary for the complete installation of the electrical work, as indicated on the Drawings, or as specified, in accordance with the requirements of all authorities having jurisdiction. The following list shall be regarded as a general and not necessarily complete indication of the principal categories and items required under this Section:

1. Temporary power and light for construction use.
2. Modify existing utility power pole to construct riser pole to provide 4,160/2,400 volt feeder from Utility to new service transformer. (Borough of Milltown manages the electrical utility all utility work shall be coordinated with Borough).
3. Provide new 4,160/2,400 volt circuit to primary of building's service transformer from utility pole. Provide all conduit, cable, and pull boxes required to establish electrical service. Work Includes coordination with Utility Company.
4. Provide new 480 Volt Service Entrance and metering equipment, including coordination with Utility Company.
5. Site duct banks and hand holes for electrical, telephone, fiber optic cable, and CATV
6. Standby power natural gas engine alternator sets and transfer switches.
7. UPS System
8. 277/480 volt and 120/208 volt lighting and power distribution systems, including panelboards, switchboards, disconnect switches, surge protective devices, transformers, etc.
9. Lightning Protection Systems
10. Receptacle wiring and branch circuits including all receptacles, floor boxes, surface raceways, etc.
11. Power wiring for mechanical equipment, including HVAC equipment plumbing equipment, etc., and 120 V a.c. control panels, and motor starter interlock wiring.
12. Grounding and Bonding.
13. Interior lighting fixtures, lamps, branch circuits, and controls.
14. Exterior lighting fixtures, lamps, branch circuits, and controls.
15. Conduit system for telephone/data outlet provisions.
16. Remote annunciators and indicator lights for UPS and Generator systems.
17. Complete fire alarm detection and notification systems.
18. Complete video surveillance system.
19. Complete card access control and alarm management system.
20. Complete voice/data wiring system including Category 6 cable, outlets, jacks, terminations, patch panels, racks, conduit and cable tray, testing and labelling
21. Excavation, trenching, concrete, backfill, compacting and rough grading for work performed under this Division of the Specifications.
22. Site power and signal wiring for reconnection of existing fuel island.
23. Site power and signal wiring for reconnection to existing salt building.
24. Site power and signal wiring for reconnection to existing vehicle block heaters.

25. Receiving, handling, protecting, rigging and assembly of equipment and materials installed under this Division of the Specifications including prepurchased equipment.
26. Structural steel supports and hangers for electrical equipment and conduit, including resupporting of existing equipment and conduit disturbed by renovation work.
27. Seismic bracing and support of electrical equipment and fixtures.
28. Furnish and set conduit sleeves and anchor bolts for equipment installed under this Division of the Specifications.
29. Penetrations and sealing/flashing conduits.
30. Cutting and patching for work installed under this Division of the Specifications.
31. Patch painting of equipment installed under this Division of the Specifications including prepurchased equipment.
32. Nameplates and danger signs for all electrical equipment.
33. "As-Built" record drawings.
34. Panel directories for lighting and power panels.
35. Lamping of all lighting fixtures.
36. Providing fuses for all fusible equipment including spare fuses.
37. Providing motor protection, overload relay.
38. Cleaning of fixtures and equipment.
39. Setting circuit breakers and protective relays.
40. Short circuit, coordination, and arc flash studies.
41. All marking and labeling including Arc Flash labeling.
42. Testing, commissioning and energizing.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. The following principal items of work shall be done under other Sections of the Specifications:

1. Through Penetration Firestop Systems
2. Door Hardware
3. Low Voltage Electrical Power Conductors
4. Grounding and Bonding
5. Hangers and Supports
6. Conduit and Boxes
7. Cable Tray for Electrical Systems
8. Vibration Isolation and Seismic Controls for Electrical Systems
9. Identification for Electrical Systems
10. Acceptance Testing for Electrical Systems
11. Low Voltage Distribution Transformers
12. Panelboards
13. Wiring Devices
14. Low Voltage Enclosed Switches
15. Enclosed Circuit Breakers
16. Motor Starter Switches and Controllers
17. Natural Gas Engine Driven Generator Sets
18. Static Uninterruptable Power Supplies
19. Automatic Transfer Switches
20. Lightning Protection for Structures
21. Surge Protective Devices
22. Lighting
23. Communications
24. Access Control
25. Video Surveillance
26. Fire Detection and Alarm

PART 2 - PRODUCTS

2.1 AS-BUILT DRAWINGS

A. Upon completion of installation, furnish the Engineer with two (2) sets of marked prints showing "as-built" light and power wiring installation, complete with wire color code information and wire tagging. The prints are the responsibility of the Contractor, with information from the Electrical Subcontractor, in fulfilling the requirements of the plans and specifications.

2.2 WIRING IN CONNECTION WITH OTHER TRADES

A. Provide conduit, wiring, appurtenances, and make all connection to motors, etc., to make the systems operate as intended in accordance with the requirements of the Specifications and as hereinafter specified.
B. Refer to shop drawings of all equipment furnished by others for proper equipment, sizes, voltage, phase characteristics, space requirements, etc., and verify with requirements on drawings.
C. Notify Architect in writing of any discrepancies before roughing for equipment.
D. Operational faults found in interconnecting of mechanical and electrical equipment shall be corrected and shall be the responsibility of the subcontractor responsible for same. In event of dispute, the Engineer will make final decision as to responsibility for correction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which all products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 TEMPORARY LIGHT AND POWER FOR CONSTRUCTION

A. Contractor shall provide on-site temporary power for all construction related work. All required on-site temporary services shall be located in areas approved by the Owner.
B. Electrical Contractor shall provide portable ground fault device to provide protected outlets for small hand tools.
C. Temporary light shall be independent of other existing lighting systems and shall be supplied from temporary power means in accordance with Electrical Code.
D. Provide socket and lamps as required to furnish adequate lighting for construction.
E. Provide temporary connections for welding equipment, etc., from source approved by the Owner.

3.3 TESTING AND COMMISSIONING

A. Refer to specification section 26 08 00, Start-up and Commissioning.

3.4 ALTERATIONS

A. Certain removals and relocations of existing electrical work will be necessary to the satisfactory performance of the general work. All changes cannot be completely detailed on the drawings, but shall be taken into consideration in making up the work proposal.
B. Continuous service is required on all circuits and outlets affected by these changes, except where the Owner will permit outage for a specific time. Obtain Engineer's and/or Owner's written consent before removing any circuit from continuous service.
C. Work shall be executed as that no unscheduled interruptions are incurred.
D. Whenever it is required to disconnect or remove any part of an existing circuit, reconnect that circuit to re-establish service in the remaining portion of the circuit.
E. Cut back to floor, wall, or ceiling and plug both ends of concealed conduits made obsolete by alteration. Remove exposed conduits, wireways, outlet boxes, pull boxes, and hangers made obsolete by the alterations, unless specifically designated to remain.
F. Provide blank plates for all unused outlet boxes affected by these alterations.
G. Modify existing panel directories to indicate any circuit changes.

3.5 EXTENSION OR REPLACEMENT OF EXISTING CONDUIT AND CABLE

A. Verify conduit and cable sizes and capacities of the existing installations with the information on the drawings.
B. Where discrepancies between existing installations and data indicated on the drawings exist, notify Engineer before the extension or replacement of existing conduit and cable work is started.

END OF SECTION 26 05 03

SECTION 260513 – MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:
   1. Drawings and general provisions of the Subcontract apply to this Section.
   2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:
   1. Single conductor, medium voltage power cable.
   2. Cable - Grounding.
   3. Medium voltage cable terminations, pole cut-outs, and arresters.
   4. Testing of medium voltage cable, splices and terminations.

C. Related Sections:
   1. Section 26 05 01 "General Electrical provisions."
   2. Section 26 05 03 “Electrical Related Work”
   3. Section 26 05 26 “Grounding and Bonding
   4. Section 26 08 00 “Start-up And Comissioning”

1.2 REFERENCES

A. General:
   1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
   2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

B. ASTM International:
   1. ASTM B-3, B-8, and B-496 - American Society for Testing Materials.

C. NFPA 70 - National Electrical Code.

D. AEIC CS8 - Association of Edison Illuminating Companies.

E. ICEA Publication No. S-94-649 NEMA WC7 - Insulated Cable Engineers Association.

F. IEEE 48 - Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

G. NEMA WC 8 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

H. NETA – National Electrical Testing Association

I. Underwriters' Laboratories, Inc. (UL 1072).

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer’s product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.

C. Product Data: Provide information for each type of product specified.

D. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;

4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

E. Submitted product data shall include the following:
1. Diameter of cable.
2. Weight of cable in pound per foot.
3. Complete description of cable, insulation production compound code number.
4. Trade name.
5. Written warranty.
6. Recommend splicing and termination methods.
7. Recommended bending radius.
8. Maximum length of cable on standard reel.
9. Net price of cable per 1,000 feet (305 m) delivered.
10. Additional price of reels, refundable on return to manufacturer.
11. Delivery date.

F. Confirmation that the cable meets the requirements of Paragraph 2.2.F.1 ICEA Publication No. S-94-649 shall be supplied with quotations.

G. Manufacturer's Documentation: After approval the cable manufacturer shall furnish through the Subcontractor to the Engineer the following:
1. Three copies of Certified Test Reports on tests required in Paragraphs 2.2.F.2 and 2.2.F.3 ICEA Publication No. S-94-649 shall be provided for each cable.
2. Proof that cable has been manufactured within six months of its installation.
3. Two copies of the manufacturer's splicing and termination procedures for approval.

H. Calculations: The Subcontractor shall provide pulling tension and sidewall pressure calculations for pulling in both directions of each cable pull. Include drawings of actual duct layouts indicating duct lengths, size and material and bend radius and degrees of arc between pulling points.

I. Product literature and samples of materials for circuit labeling.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Company experienced in manufacturing Products specified in this Section with minimum of 10 years.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cablec Industrial Cable Co., Kerite Co., Okonite Co., Pirelli Cable Corp., or equal.

2.2 15KV CABLE

A. This Specification describes requirements for 15kV Class (100 percent Insulation level) single conductor cable with 1/3 concentric neutral power cable for use in power distribution, Okoguard Type MV-90 or equal. Cable provided must be single conductor, jacketed, and insulated with a high quality, heat, moisture, impact, ozone, and corona resistant thermosetting (ethylene propylene) rubber that shall be suitable for use in wet or dry locations in conduit, underground duct systems, direct burial, and aerial installations.

B. Conductors:
1. Conductor material shall be annealed uncoated copper in conformance with ASTM B-3.
2. Conductors shall be compact-round-stranded in conformance with ASTM B-496.
3. Stranding shall be Class B unless otherwise specified.

C. Conductor shield:
1. The conductor strain shield shall be both a 2.5 mil thick extruded semiconducting material in conformance with ICEA S-94-649. Semiconductor tape shield is not acceptable.

D. Insulation:
1. Insulation shall be an ethylene propylene rubber (EPR) compound rated at 221 deg F (105 deg C) for normal operation, 285 deg F (140 deg C) for emergency overload conditions, and 482 deg F (250 deg C) for short circuit conditions.

2. Other synthetic rubber based insulations are acceptable if they meet the above operating temperatures and are unaffected by ozone and electric discharge and proven by the insulation's ability to withstand continuous exposure to electrical discharge for more than 2,000 hours when energized at a test potential equal to 250 volts/mil of insulation thickness. The test procedure shall be that described in ICEA S-94-649.
3. The insulation material shall meet the electrical and physical requirements specified in ICEA S-94-649.
4. The average insulation thickness shall be no less than 220 mils; the minimum thickness at any point not less than 90 percent of the specified thickness.

E. Insulation Screen:
1. The insulating shield shall consist of semiconducting non-metallic, extruded covering, in conformance with ICEA S-94-649, directly over the insulation and a non-magnetic metal tape, in conformance with ICEA S-94-649, directly over the semiconducting covering. Substitution of a non-metallic semiconducting tape for the extruded covering is not acceptable.

F. Concentric Neutral:
1. Provide copper wires helically applied over the insulation shield, where the minimum total cross sectional area (of the shield wires) is 1/3 of the core conductor. Minimum size of an individual shield wire is 1.6 millimeter No. 14 AWG.

G. Overall Jacket:
1. A continuous, extruded, tight fitting, non-conductive, abrasion, moisture, heat, weather, solvent and flame resistant black thermosetting Chlorinated Polyethylene (TS-CPE) jacket shall be applied directly over the corrugated copper shielding, in conformance with ICEA S-94-649.
2. The overall jacket shall be free stripping from the shielding tape.
3. The minimum average thickness of the overall jacket shall not be less than 80 mils, and the minimum thickness shall not be less than 72 mils.

H. Electrical and Physical Tests:
1. Qualification tests in compliance with AEIC CS8 are required for each shielded cable furnished.
2. All materials used in construction of the cables shall be tested in compliance with the application paragraphs of ICEA S-94-649.
3. All completed cables shall successfully pass the following tests prescribed in ICEA publication S-94-649 :
   a. Par. 6.5 - Aging.
   b. Par. 6.27 - Voltage.
   c. Par. 6.28 - Insulation Resistance.
   d. Par. 6.29 - Partial Discharge Extinction (Corona) Level.
   e. Par. 6.23 - Discharge Residence.
4. Test methods and frequency of tests (for tests in F-2 and F-3 above) shall be as prescribed inICEA S-94-649.

I. Cable Identification: The following information shall be indicated, by means of a surface legend printed in compatible ink of contrasting color, at intervals not to exceed 24 inches (600 mm) over the entire length of the cable:
1. Manufacturer's name.
2. Conductor material.
3. Conductor size.
4. Maximum rated voltage.
5. Insulation material.
6. Letter designating cable type.
7. Shielded or non-shielded.
8. Date of manufacture.

J. Reel Identification: Each reel shall have printed on the reel or a weatherproof (metal or plastic) tag firmly attached indicating:
1. Manufacturer's name.
2. Conductor material.
3. Conductor size.
4. Insulation type and thickness.

5. Jacket thickness.
6. Temperature rating.
7. Length of cable.
8. Manufacturer's type.
9. Voltage class.
10. Purchaser's purchase order number and item number.
11. Cable weight.
12. Reel weight.
13. Shielded or non-shielded.
14. Date of manufacture.

K. Shipment: The cable shall be shipped in continuous lengths as specified by the Subcontractor. The shipment shall be made on carefully inspected non-returnable reels if possible. Cable ends shall be securely fastened to the reel using polypropylene rope ties. Metal ties shall not be used. Cable ends shall be completely sealed against moisture and contaminants. The cable on the reel shall be protected with plyboard or tekboard lagging held securely in place with steel banding.

L. Conductor and Shield Continuity: Each length of completed cable shall be tested for conductor and shield continuity.

M. Reports: Certified copies of Production Tests specified in Paragraph 2.2.F shall be furnished for each shipment of cable.

2.3 POLE MOUNTED CUTOUTS

A. Basis of design polymer-insulated Type L Open Distribution Cutout with NEMA B bracket, back strap, and hardware kit model S4B2E1A as manufactured by Cooper Power Systems or equal by Hubbell.

B. Cutout shall be UltraSIL Polymer-insulated type.

C. Voltage rating 15.5kV, 110kV BIL

D. Fuse Holder: 200amp Max., fuse size as shown on drawings.

E. Prior to purchase confirm maximum short circuit interrupting current with Utility.

2.4 CABLE TERMINATIONS

A. Manufacturers:
1. 3M, Cooper Power Systems, Raychem or equal.

B. Description: IEEE 48; Class 1, molded rubber cable termination in kit form with stress cone, ground clamp, non-tracking rubber skirts, utilizing molded elastomer, wet process porcelain, pre-stretched, and heat-shrinkable terminations utilizing factory preformed components to the maximum extent practicable, rather than tape build-up. Terminations shall have a basic impulse level as required for the system voltage level.

2.5 POLE RISER MOUNTED DISTRIBUTION SURGE ARRESTER

A. Basis of design Cooper Power Systems UltraSIL polymer-housed VariSTAR riser pole (10kA) Medium Voltage surge arrester model URS03040BA1BE81A.

B. Provide arrester with isolator, insulated hanger, and NEMA cross-arm bracket.

C. Arrester rating: 3kV, MCOV 2.55kV (Selection based on 3-wire low impedance grounded system, verify with Utility prior to purchase.)

2.6 CIRCUIT LABELS

A. Manufacturers:
1. Almetek Industries, Type E-Z -Tag; Seton, Type or equal.

B. Description: Cable circuit labels shall be 1-1/2 (38 mm) high, polyethylene, with black on yellow characters, in a polyethylene holder, attached to the cable by two nylon self locking ties.

2.7 LOADBREAK ELBOWS

A. Provide 200amp, 15kv class loadbreak connectors for terminations to transformer primary HV loadbreak bushings.

B. Loadbreak connectors shall be constructed in accordance with IEEE standard 386-latest edition.
C. Loadbreak construction: Molded from high quality peroxide-cured insulating and semi-conducting EPDM rubber, coppertop connector, tin-plated copper loadbreak probe with ablative arc-follower tip, stainless steel reinforced pulling eye, and capacitive test point.

2.8 FIREPROOFING TAPE

A. Manufacturers:
   1. 3M, Type, Plymouth, Type or equal.
   2. Substitutions: Under provisions of Division 01 Section "General Requirements".
B. Description: The tape shall be noncorrosive to cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage, or fungus.

PART 3 - EXECUTION

3.1 15KV CABLE INSTALLATION

A. Carefully protect cable from mechanical damage. Provide suitable mechanical protection for reels.
B. Pull cable directly from reels into the ducts. It may not be laid on the ground or otherwise handled for cutting or sorting. Pulling lubricant, UL-listed and compatible with the cable being pulled, as manufactured by IDEAL, Y-ER-EAS, or equal, shall be generously applied. Pulling tension (lbs) not to exceed 0.008 times the circular-mil cross-sectional area of the conductor. Cables shall not be pulled through more than one intermediate manhole on one pull. Cable ends shall be sealed against moisture after pulling. Pull ropes shall be non-metallic to prevent cutting of duct materials.
C. Pulling tension and side wall pressure shall not exceed the manufacturer’s allowable values. Pulling tension shall be continuously monitored during a pull by use of a dynamometer. The dynamometer shall have been calibrated within a year of its use on the project. If the pulling tension or sidewall pressure is exceeded during a pull, the cable shall be considered damaged and shall be replaced by the Subcontractor.
D. Installation of Cables in Manholes and Handholes: Cable shall not be installed utilizing the shortest route, but shall be routed along those walls providing the longest route and the maximum spare cable lengths. Cables shall be formed closely parallel to the walls, shall not interfere with duct entrances, and shall be supported on brackets and cable insulators, spaced at a maximum of four feet. In existing manholes and handholes where new ducts are to be terminated or where new cables are to be installed, the existing installation of cables, cable supports, and grounding shall be modified as required for a neat and workmanlike installation with cables properly arranged and supported.
E. Split wire-basket cable grips shall be used to restrain conductors in manholes, handholes, and pull boxes on downhill duct runs.
F. Splicing of cable within manholes shall be as recommended by the cable manufacturer. The Subcontractor shall furnish for approval two (2) copies of the manufacturer's splicing and termination procedures. Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes or handholes. Maintain existing phase rotation after splicing in the new sections of cables.
G. Splicing shall be done by a qualified subcontractor specializing in high-voltage splicing and testing, using experienced cable splicers having experience.
H. Splices in Shielded Cables: Splices in shielded cables shall include covering the spliced area with metallic tape, or like material, to the original cable shield and by connecting it to the cable shield on each side of the splice. Provide a No. 12 AWG or larger solid copper ground connection brought out in a watertight manner and grounded to a 3/4 inch by 10 foot (18mm by 3m) ground rod as part of the splice installation. Wire shall be trained to the sides of the enclosure in a manner to avoid interference with the working area.
I. The 4/0 AWG bare copper-conductor ground wire shall be bonded to existing and new ground rods in manholes.
J. Fireproofing (arc proofing) of cables in manholes, handholes, and vaults: Medium voltage cables, in manholes and handholes, shall be fireproofed. Strips of fireproofing tape, approximately 1/16 inch (1.5 mm) thick by 3 inches wide (75 mm), shall be wrapped tightly around each cable spirally in a half-lapped wrapping, or in two butt-jointed wrappings with the second wrapping covering the joints in the first. To prevent unraveling, the fireproofing tape shall be random wrapped, the entire length of the fireproofing, with

pressure sensitive glass cloth tape. The fireproofing tape shall consist of a flexible, conformable fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick (1.3 mm) and shall weigh not less than 2.5 pounds per square yard (1.436 k/m²). The tape shall be applied with the coated side toward the cable and shall extend one inch into ducts.

3.2 15KV CABLE LABELING

A. 15kV circuits shall have each phase tagged (A, B, or C) at termination points and on either side of each splice in a man hole, using plastic tie-tags.

B. At each manhole, handhole or pull box, 15kV circuit labels, as shown on the drawings, shall be attached to each cable group. As the cable enters it shall be labeled to identify the source. As the cable leaves it shall be labeled to identify its destination. At approximately the center of the cable group it shall be identified with its feeder circuit designation.

3.3 TEST LABORATORY

A. The Subcontractor shall provide the services of a recognized independent testing laboratory/company for the purpose of performing inspections and tests on the cable installation. The testing laboratory/company shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907. Membership in the National Electrical Testing Association constitutes proof of meeting such criteria. The testing laboratory/company shall submit proof of the above qualifications through the Subcontractor to the Engineer. The testing laboratory/company shall provide material, equipment, labor, and technical supervision to perform such tests and inspections. The tests and inspections shall determine the suitability, of the cable installation for energization.

3.4 15KV CABLE TESTING IMMEDIATELY AFTER INSTALLATION

A. Immediately after cables have been installed, the Subcontractor shall notify the testing laboratory/company, engineer and the Owner when the installation is available for testing. The Owner or its representative shall witness testing.

B. Each conductor shall be individually tested with other conductors grounded. Shields shall be grounded.

C. A dc high potential shall be applied in at least 8 equal increments until a maximum of 55kV is reached. Dc leakage current shall be recorded at each step, allowing stabilization time for system charging current decay. A graphic plot shall be made of leakage current (x axis) versus voltage (y axis) at each increment.

D. The tested conductor shall be raised to the maximum test voltage and held for fifteen minutes. Readings of leakage current (y axis) versus time (x axis) shall be recorded and plotted at thirty second intervals for the first two minutes and then at each minute thereafter.

E. A shield continuity test shall be performed by the ohmmeter method. The ohmic value shall be recorded.

F. The test laboratory/company shall maintain a written record of tests and, upon completion of the project, assemble and certify a final test report no later than ten days after completion of the tests. The Owner shall receive 3 copies of the final test report.

3.5 15KV CABLE TESTING AFTER SPLICING AND END TERMINATION PREPARATION

A. Immediately after cables have been spliced and cable ends prepared for termination, but not connected to equipment, the Subcontractor shall notify the testing laboratory, engineer and the Owner when the installation is available for testing. The Owner or its representative shall witness testing.

B. Each conductor shall be individually tested with other conductors grounded. Shields shall be grounded.

C. A dc high potential shall be applied in at least 8 equal increments until a maximum of 30kV is reached. Dc leakage current shall be recorded at each step, allowing stabilization time for system charging current decay. A graphic plot shall be made of leakage current (x axis) versus voltage (y axis) at each increment.

D. The tested conductor shall be raised to the maximum test voltage and held for fifteen minutes. Readings of leakage current (y axis) versus time (x axis) shall be recorded and plotted at thirty second intervals for the first two minutes and then at each minute thereafter.

E. A shield continuity test shall be performed by the ohmmeter method. The ohmic value shall be recorded.

F. The test laboratory/company shall maintain a written record of tests and, upon completion of the project,

assemble and certify a final test report no later than ten after completion of the tests. The Owner shall receive 3 copies of the final test report.

END OF SECTION 260513

SECTION 26 05 19 - WIRE, CABLE AND CONNECTORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Conductor sizes are indicated on the Drawings. The Contractor shall verify the ampacity of conductor sizes against the rating of the respective protective devices, and shall notify the Engineer of any discrepancies.

B. Wire and cable shall be U.L. listed for the application for which it is used.

1.2 REFERENCES

A. American Society for Testing Materials (ASTM):
   1. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. National Fire Protection Association (NFPA):
   3. NFPA 70 National Electrical Code (NEC).
   4. Underwriter's Laboratories, Inc. (UL):
   5. UL 13 Standard for Power-Limited Circuit Cables.
   6. UL 44 Thermoset-Insulated Wires and Cables
   7. UL 83 Thermoplastic-Insulated Wires and Cables
   8. UL 486A/B Wire Connectors
   9. UL 486C Splicing Wire Connectors.
   10. UL 486D Sealed Wire Connector Systems
   11. UL 486E Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
   12. UL 510 Standard for Insulating Tape
   13. UL 1569 Standard for Metal-Clad Cables.

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.

B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.

C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   1. Wire and Cable
   2. Connectors

1.4 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data: Submit manufacturer's technical data for each component of system specified, including product specifications and installation instructions.
   1. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.

C. Shop Drawings: Included plans, elevations, sections, details, penetrations, terminations, fasteners and attachments to other work.

D. Samples: for each product provide color and texture samples requested by Architect.
   1. Initial Selection: Submit manufacturer's color sheets and small-scale samples indicating manufacturer's full range of colors and textures for selection by Architect.
   2. Verification: Submit 8-inch x 8-inch samples for each finish, color and texture selected; prepare samples using same tools and techniques intended for actual work.

E. Field quality-control test reports.

F. Product certificates and test reports.

G. Research / evaluation reports.

H. Maintenance data.

I. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post – consumer content.
   2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

J. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES;
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

K. Quality Control Submittals:
   1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer indicating compliance with applicable "Qualifications" requirements specified below.
   2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with requirements specified below.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Unless otherwise indicated on drawings, all conductors shall be soft-annealed uncoated copper. No. 12 branch circuit wires shall be solid, larger than No. 12 shall be stranded. All motor leads and control wires shall be stranded. All wires used to connect lighting fixtures to branch circuits or between lighting fixtures shall be stranded.

B. The jacket of all wire and cable shall be printed with the following information:
   1. Manufacturer
   2. Conductor Size
   3. Insulation Type
   4. Maximum Voltage
   5. UL Label

C. Conductor insulation shall be rated 600 volts, 90°C, Type THWN/THHN and conform with the latest Specifications and Standards of the NEC.

D. Fixture connections to branch circuits shall be made using stranded wire with insulation temperature rating equal to or higher than that of wire supplied with the fixture, or specified by fixture manufacturer.

E. All UL listed manufacturers are approved provided they subscribe to UL re-inspection service for the type of wire or cable indicated and/or specified.

F. Type W cable listed for extra hard usage with insulation rated at 2000V, 90°C, EPDM with a CPE jacket may be used for temporary feeders from a portable generator.

G. Diesel locomotive cable rated at 2000V, 90°C, EPDM with a CPE jacket may be used for the connection of the batteries to the generator engine starter.

H. Jacketed, shielded and non-shielded, plenum rated UL Listed, FPLP cable may be used above ceilings for signaling and initiating devices in finished spaces. For exposed areas such as equipment/mechanical rooms, generator room, electric rooms and telecommunication spaces, cable shall be in EMT as a minimum.

2.2 COLOR CODING

A. Consistent phase identification of all wires from service feeders to branch circuit wires shall be maintained as follows:

PHASE	**208/120V,3P,4W**	**480Y/277V,3P,4 W**
A	**Black**	**Brown**
B	**Red**	**Orange**
C	**Blue**	**Yellow**
Neutral	**White**	**Gray**
Ground	**Green**	**Green**
PHASE	**208/120V,3P,4W**	**480Y/277V,3P,4 W**

B. For short runs (where total length of single conductor cables does not exceed 100 feet) of the larger cables, instead of providing differently colored insulation's, the cables may be taped using half-lapped pressure sensitive tape on both ends with the proper coloration, a distance of no less than 3 inches.

2.3 MINIMUM WIRE SIZES

A. For lighting and convenience outlet circuits use 12AWG (#10 AWG for runs 75’ or more) unless otherwise specified. Use No. 10AWG wire for circuits where distance from lighting panel to first outlet or fixture exceeds 75 feet. Fixture connections No. 14AWG may be used to connect a fixture to branch circuit.

2.4 CONNECTORS

A. All connections, splices, taps, and joints shall be made with solderless devices and shall be mechanically and electrically secure. Ordinary screw terminals with wraparound connections may be used with No. 10 and smaller copper wires. Exposed wires and connecting devices shall be protected with electrical tape or insulation to provide insulation not less than on conductor.

B. For large cables, #8 and larger, use compression type connectors, taps, and splices, specifically designed for the particular connection.

C. Use 2 bolt hole long barrel compression type lugs for wire size above #2AWG.

D. Insulate splice either by taping or by use of covers designed to fit around splice, or by "shrink" method of approved manufacturers: O-Z, 3-M Company, Burndy, Thomas & Betts.

E. For branch circuit wires #10 and smaller, the following types of terminals and connecting devices may be used:

F. Terminals on Wire Ends: Either wedge pressure devices (Thomas & Betts "wedge-On") or open end lugs (Burndy "Hy-Lug", Thomas & Betts "Sta-Kon", Buchanan "Termend").

G. Spring-held Connectors: Approved devices - Minnesota Mining and Manufacturing Co. "Scotchlock", Ideal Industries, "Wing-Nut" connector or "WireNut" connector, Thomas & Betts "Pigtail" connector.

H. Crimp Compression Connectors with specially fitted plastic or rubber insulating cover. Approved devices: Ideal Industries #410 crimp connector and "Wrap-Cap", Thomas & Betts "Sta-Kon" connector, Buchanan #3008S connector with nylon splice cap.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. All conductors shall be continuous from origin to panel or equipment without splices. Where tap splices are necessary and approved, they shall be made in approved splice boxes with suitable connectors.

B. All wiring must be installed in conduit or other acceptable raceway unless otherwise indicated.

C. Use lubricant for pulling wires only when necessitated by possibility of damage to wires.

D. Train and lace wiring inside equipment and panelboards in a neat and workmanlike manner. Make spare wires in cabinets or panelboards of sufficient length for connection to the most remote terminal in the enclosure. All wires for future connection to external circuits shall be terminated with insulating tape and tagged.

E. All conductors connected to bus shall be 2 bolt hole long barrel compression lugs of size to match conductor.

F. For fire alarm systems, plenum rated signal wire may be used above drop ceilings in administrative areas only for detector and annunciator loops only. In all other locations, applications, and circuits, fire alarm system wiring must be in conduit.

G. All possible care shall be taken in the pulling of wiring into conduits and other raceways to prevent damage to the insulation. The cable reels or coils shall be set up in such a way that the conductors may be trained into the raceway as directly as possible with a minimum bending. Where several cables are contained in one conduit, all cables shall be pulled together.

H. Maximum allowable pull tension as specified by the cable manufacturer shall not be exceeded. Cables shall not be bent or pulled around sheaves less than the manufacturer's recommended minimum bend radius.

3.3 TESTING

A. Perform insulation resistance and continuity test for all feeder and branch circuit conductors and

record the test results. Tests shall be completed prior to energization.

B. Investigate and take remedial action when continuity values exceed 0.1 OHMS and/or insulation resistance tests less that 5,000,000 OHMS.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall furnish all the equipment specified herein, in conformance with the terms and conditions stated. The contractor shall coordinate and verify the interface between each component provided to assure they are compatible and will operate properly in conjunction with each other.

B. Provide grounding and associated equipment in accordance with the NEC:
   1. Grounding Electrode System and Conductors
   2. Equipment Grounds
   3. ITS room ground system
   4. Radio system grounding
   5. Halo ground (Perimeter Ground)
   6. Bonding jumpers
   7. Lightning protection

C. The Contractor shall install the specified equipment, and shall provide all incidental materials noted or reasonably implied in these specifications or on the drawings. The Contractor shall make all connections and perform all installation procedures in accordance with the manufacturer's instructions.

D. The Contractor shall install the specified equipment, and shall provide all incidental materials noted or reasonably implied in these specifications or on the drawings. The Contractor shall make all connections and perform all installation procedures in accordance with the manufacturer's instructions.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Surge Protection Devices
B. Lightning Protection

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer’s product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
   1. Ground rods
   2. Ground wire
   3. Connectors
   4. Exothermic welds
   5. Ground well

C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work to describe the work.
   1. Manufacturer to propose spacing and layout of supporting devices including heights, spacing, and frequency.

D. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

PART 2 - PRODUCTS

2.1 GENERAL

A. Ground terminations, clamps, bushings, etc. shall be listed for the purpose and shall be installed in accordance with manufacturer's recommendations.
B. Provide exothermic weld connections to driven ground rods, building steel, and buried ground grids. Ground rods shall be minimum 3/4” – 10ft copper clad ground rods..
C. Provide ground clamps on raised floor pedestals.

2.2 MATERIALS

A. Wire:
   1. Bare Ground Wire:
      a. Bare grounding conductors shall be soft drawn stranded copper sized in accordance with the Contract Documents.
   2. Insulated Ground Wire:
      a. Insulated grounding conductors shall be stranded copper conductors. B.
      b. Equipment grounding conductors installed with 600 volt insulated feeder or branch circuits shall be provided with the same insulation type as the current carrying conductors.
B. Non-Welded Connections:
   1. Lugs shall be tin plated high conductivity copper compression type. For conductors No. 2/0 and larger, provide two-hole long barrel type. For conductors No. 1/0 and smaller, provide one-hole short barrel type.
   2. Pipe clamps shall be brass with bronze hardware.
   3. Acceptable Manufacturers
      a. Ilsco
      b. Thomas & Betts
      c. Ideal Industries
C. Exothermic Welding Kits:
   1. Provide molds, thermite packages, and other material for exothermic welds that are rated to carry 100 percent of the cable ratings, and which are letter-coded exothermic welded type. All materials shall be from a single manufacturer.
   2. Provide all items such as tees, crosses, splices, and cable connections necessary for connecting ground and bonding cables to the following items:
      a. Ground rods.
      b. Reinforcing steel bars.
      c. Buried connections.
      d. Concrete encased connections.
      e. Acceptable Manufacturers:
      f. Erico, Cadweld®.
      g. Continental Industries, Inc., Thermoweld®.
      h. Approved equal.
D. Ground Rods:
   1. Provide UL listed, sectional ground rods fabricated using a molten weld casting process to copper clad a medium carbon steel core
   2. Diameter: 3/4 inch.
   3. Length: 10 feet.
   4. To obtain longer length rods, join rod sections using copper clad rod couplers.
   5. Acceptable Manufacturers:
      a. Erico International Corp.
      b. Galvan Industries, Inc.
      c. South Atlantic, LLC
      d. A.B. Chance Co.
E. Concrete Protective Boxes (Ground Wells):

a. Provide precast concrete boxes with flush cast iron covers rated for heavy traffic H20 areas and having slots for conduit entrances.
b. Minimum size: 10” diameter by 12” high with maximum depth up to 36”.
c. Cover legend: Provide the cast-in legend “GROUND TEST WELL” in the cast iron covers provided.

F. Acceptable Manufacturers:
a. National Lightning Protection Corporation
b. East Coast Lightning Equipment
c. Or Approved Equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner’s Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner’s Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 EQUIPMENT GROUNDING

A. Wire raceway, cable armor, panelboards, switchboards, motors, and other non-current carrying metal parts shall be mechanically joined to form a continuous conduction metallic path and assure electrical continuity of the grounding circuits.
B. In addition, an Equipment Grounding Conductor commonly described as a "green wire", shall be provided for all feeders and branch circuits protected by over-current devices rated 15 amps and over. Also, such grounding conductors shall be provided for all motor circuits and raceways buried in the earth or using flexible conduit.
C. The equipment-grounding conductor shall be in the same raceway as the phase conductors and shall be insulated. When multiple raceways are required provide a separate grounding conductor for each raceway. The size of the equipment ground conductor shall be in accordance with the plans in multiple raceways. At pull boxes, panelboards and switchboards connect the grounding conductor to the ground bus and/or ground lug.
D. Transformer neutrals shall be grounded to the building structure, in accordance with the N.E.C.
E. Test all ground cables for continuity. Bare or insulated ground cables for electrical system and/or equipment enclosures shall be tested between ground sources and power equipment ground busses and between ground busses and individual equipment enclosures or transformer neutrals. Investigate and take remedial action when continuity values exceed 1 OHM.

3.3 TELE/DATA GROUND SYSTEM

A. Bond Tele/Data ground system to electrical grounding electrode system.
B. Provide all wire and hardware required to properly ground, bond and connect Tele/Data raceway, cabletray and equipment to ground source.
C. Grounding bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.
D. Provide ground path that are permanent and continuous with a resistance of 1 ohm or less form raceway, cabletray and equipment connections to the building grounding electrode.

3.4 INSTALLATION

A. Ground Rods: Drive ground rods until tops are two inched below finished floor or final grade, unless otherwise indicated. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating. Verify that final backfill and compaction has been completed before driving electrodes.

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

C. Bonding Straps and Jumpers: Install so vibrations equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic welded connectors for outdoor locations, unless a disconnect type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters and air cleaners. Use braided type bonding straps.

E. Installing Ground Wells:
   1. Install a concrete protective box for the ground well flush with the grade and 4 inches above the top of the ground rod designated on the Contract Drawings.

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot tin coated materials to ensure high conductivity and to make contact points closer to order galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.
   4. Make aluminum to galvanized steel connections with tin plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
   6. Exothermic Weld Connections: all connections to building steel shall be exothermic welded type. Comply with manufacturers written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

B. Equipment Grounding Conductor 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.

C. Tighten screws and bolt for grounding and bonding connectors and terminal according to manufacturer's published torque-tightening values. If manufacturer's torque value are not indicated, use those specified in UL 486A.

D. Compression Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for comparison connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

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

3.6 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality control testing:
   1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform test the fall of potential methods according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
    a. Equipment Rated 500 kVA and Less: 5 ohms
    b. Equipment Rated 500 to 1000 kVA: 5 ohms
    c. Equipment Rated More Than 1000 kVa: 3 ohms
    d. Pad-Mounted Switching Equipment: 5 ohms
    e. Manhole grounds: 10 ohms
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, add additional ground rods as required to achieve specified resistance. Notify Architect promptly and include recommendations to reduce ground resistance.

B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION 26 05 26

SECTION 26 05 30 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The Work specified in this Section consists of furnishing and installing hanger and support systems for electrical raceway, conduit boxes, and equipment.
B. Related Sections:
   1. The requirements of Section 260503, Related Electrical Work including related sections apply to the Work of this Section.

1.2 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.
B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.

1.3 REFERENCES

A. ASTM International:
B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
C. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
D. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
E. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
F. FM Global:
G. 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
H. National Fire Protection Association:
I. NFPA 70 - National Electrical Code.
J. Underwriters Laboratories Inc.:
K. UL 263 - Fire Tests of Building Construction and Materials.
L. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
M. UL 1479 - Fire Tests of Through-Penetration Firestops.
N. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
O. UL - Fire Resistance Directory.

1.4 FIRESTOPPING PERFORMANCE REQUIREMENTS

A. Firestopping Materials: Achieve fire ratings for adjacent construction, but not less than 1 hour fire rating.
B. Firestopping: Conform to applicable code FM, UL, and WH for fire resistance ratings and surface burning characteristics.
C. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.5 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.
B. Provide evidence of testing agency verification, listing and labeling either by printed mark on

the data sheet or by a separate listing card.

C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
   3. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Shop Drawings: Submit Shop Drawings for the following items:
   1. Equipment supports.
   2. Trapeze conduit supports.
      a. Indicate system layout with location and detail of trapeze hangers.
      b. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.
   3. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post – consumer content.
   2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

G. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.6 FIRE STOPPING QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings, but not less than 1-hour.

B. Wall Penetrations: Fire F-Ratings, but not less than 1-hour.

C. Floor and roof penetrations: Fire F-Ratings and temperature T-Ratings , but not less than 1-hour. a. Floor Penetrations Within Wall Cavities: T-Rating is not required.

D. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

E. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.

F. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

G. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating for assembly in which joint is installed.
H. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating for floor assembly.
I. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
J. Maintain one copy of each document on site.
K. Comply with CBC Seismic and Gravity Design Criteria.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage. By storing in original packing.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).
B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

PART 2 - PRODUCTS

2.1 ANCHORS AND FASTENERS

A. Drive (Deep-Pitch) Screws: Self-tapping type, 316 stainless steel, Fed. Spec. FF-S-107C(2).
B. Drilled-In Anchors and Fasteners: Fed. Spec. FF-S-107C (2).
1. Applications in Masonry (and Precast Concrete Hollow-Core Structural Elements):
a. Anchors: Provide anchors designed to accept both machine bolts and threaded rods. Provide anchors consisting of an expansion shield and expander nut contained inside the shield. Provide expander nut fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches and bears against the shield bottom.
b. Shield Body: Provide shield body consisting of four legs, the inside of each tapered toward shield bottom (or not end). The end of one leg shall be elongated and turned across shield bottom. Outer surface of shield body shall be ribbed for grip-action.
c. Expander Nut: Provide square design with sides tapered inward from bottom to top.
d. Material: Provide die cast Zamac No. 3 zinc alloy of 43,000 psi minimum tensile strength.
e. Fasteners: Provide 316 stainless steel machine bolts conforming to S.A.E. Grade 2 for use with above anchors: nuts and washers to conform to ASTM A 563.
f. Acceptable Manufacturers:
1) U.S.E. Diamond, Inc.; FORWAY System.

C. Applications in Cast-in-Place Concrete (and Solid Precast Concrete Structural Elements):
   1. Anchor/Fastener: Provide UL listed and one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1.
   2. Stainless Steel Anchor/Fastener: Provide one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of Fed. Spec. FF-S-325, Group II, Type 4, Class 1. Stud of AISI Type 303 or 304 stainless and nut and washer of AISI Type 316 stainless.
   3. Acceptable Manufacturers:
      a. U.S.E. Diamond, Inc.; SUP-R-STUD.
      b. Hilti Fastening Systems; KWIK-BOLT.
      c. Molly Fastener Group; PARABOLT.
      d. Phillips; RED HEAD Wedge-Anchor.

D. Note: Hammer drive-type explosive charge anchors and fastener systems are not acceptable. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems are not acceptable. Adhesive fasteners are not acceptable.

E. Provide bolts, nuts, and washers smaller than 1/4-inch trade size 316 stainless steel: ASTM A 325 galvanized to ASTM A 153/A 153M for galvanized components.

F. Welding materials: AWS D1.1; type required for materials being welded.

G. Touch-up primer: SSPC-Paint 15, Type 1, red oxide.

H. Touch-up primer for galvanized surfaces: SSPC-Paint 20, Type I, inorganic zinc.

2.2 CONDUIT SUPPORTS

A. Manufacturers:
   1. Allied Tube & Conduit Corp.
   2. Powerstrut.
   3. Unistrut.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F (85 degrees C). Self locking.

2.3 FORMED STEEL CHANNEL

A. Manufacturers:

B. Allied Tube & Conduit Corp.

C. Unistrut Corp.

D. Powerstrut.

E. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.4 SLEEVES

A. Furnish materials in accordance with standards.

B. Sleeves for conduits through Non-fire Rated Floors: 18 gage (1.2 mm) thick galvanized steel.

C. Sleeves for conduits through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18gage thick galvanized steel.

D. Sleeves for conduits through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing:

1. Prefabricated fire rated sleeves including seals, UL listed.

E. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
B. Thunderline Link-Seal, Inc.
C. NMP Corporation.
D. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 FIRESTOPPING

A. Manufacturers:
   1. Dow Corning Corp.
   2. Hilti Corp.
   3. 3M fire Protection Products

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
C. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
D. Foam Firestopping Compounds: Multiple component foam compound.
E. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
F. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
G. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
H. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
I. Firestop Pillows: Formed mineral fiber pillows.

2.7 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
B. Dam Material:
C. Permanent:
   1. Mineral fiberboard.
   2. Mineral fiber matting.
   3. Sheet metal.
D. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
E. General:
   1. Furnish UL listed products or products tested by independent testing laboratory.
   2. Select products with rating not less than rating of wall or floor being penetrated.
F. Non-Rated Surfaces:
   1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.

2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
B. Remove incompatible materials affecting bond.
C. Install backing materials to arrest liquid material leakage.
D. Do not drill or cut structural members.
E. Obtain permission from Structural Engineer before drilling or cutting structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
   1. Concrete Structural Elements: Provide precast inserts systems, expansion anchors, and preset inserts.
   2. Steel Structural Elements: Provide beam clamps with spring steel clips, steel ramset fasteners, and welded fasteners.
   3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
   4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
   5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
   6. Sheet Metal: Provide sheet metal screws.
   7. Wood Elements: Provide wood screws.

B. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
   6. Install conduit and raceway support and spacing in accordance with NEC.
   7. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
   8. Install multiple conduit runs on common hangers.

C. Supports:
   1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
   2. Install surface mounted cabinets and panelboards with minimum of four anchors.
   3. In wet and damp locations install steel channel supports to stand cabinets and
   4. Panelboards 1 inch off wall.
   5. Support vertical conduit at every floor.

3.4 INSTALLATION – FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.
B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
D. Compress fibered material to maximum 40 percent of its uncompressed size.
E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
F. Place intumescent coating in sufficient coats to achieve rating required.
G. Remove dam material after firestopping material has cured. Dam material to remain.
H. Fire Rated Surface:
I. Seal opening at floor, wall, partition, ceiling, and roof as follows:
J. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
K. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
L. Pack void with backing material.
M. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
N. Where cable tray and conduits penetrate fire rated surface, install firestopping product in accordance with manufacturer's instructions.
O. Non-Rated Surfaces:
P. Seal opening through non-fire rated wall, floor, ceiling, and roof opening as follows:
Q. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
R. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
S. Install type of firestopping material recommended by manufacturer.
T. Install escutcheons floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
U. 5. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 12 inches beyond supported equipment.
B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.

3.6 INSTALLATION – SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
C. Set sleeves in position in forms. Provide reinforcing around sleeves.
D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
E. Extend sleeves through floors 1inch above finished floor level. Caulk sleeves.
F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
G. Install stainless steel escutcheons at finished surfaces.

3.7 FIELD QUALITY CONTROL

A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 26 05 30

SECTION 26 05 33 - CONDUIT, BOXES, WIREWAY AND FITTINGS

PART 1 -GENERAL

1.1 SUMMARY

A. Section Includes: The Work specified in the Section includes furnishing and installing conduit, tubing, boxes and fittings for electrical wiring.

1.1 RELATED SECTIONS

A. Related Sections include the following:
   1. Section 26 05 19 – Wire, Cable and Connections

1.2 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
   1. Product Data: Provide information for each type of product specified.

C. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

D. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.3 CONDUIT AND FITTINGS

A. Conduit to be UL labeled and sized in accordance with NEC minimum size 3/4". Conduit to be UL approved for purpose or location in which it is to be used.

B. Conduit shall be a minimum of ¾" for all applications except Fire Alarm Systems. For Fire Alarm Systems, ½" conduit is permitted for signaling and communications loops only, where no more than two pairs of signal wires are run in the conduit or in accordance with the NEC conduit fill requirements, which ever is less. For control wiring of temperature control systems, ½" conduit is permitted for low voltage signaling wiring. In all applications, circuits 120V (L-N) or greater shall be in minimum ¾" conduit.

C. All wiring for low tension, controls, communications and all other systems shall be in raceway

specified for branch circuits unless specifically noted in other sections.

D. All EMT and IMT conduit fittings shall be steel compression type.

E. Die cast conduit fittings or hardware of any type, are not permissible.

1.4 TYPES AND APPLICATIONS

A. Types of conduit to be as follows for all feeders and distribution circuits, unless otherwise noted or prohibited by Code:

APPLICATION	TYPES OF CONDUIT
Surface Mount Indoors Building Only	**EMT, Rigid Galvanized Steel**
Concealed	**EMT, MC Cable (Branch Circuit Only)**
Attached to Motors	**Flexible Liquid Tight**
Exposed Outdoors	**Galvanized Rigid Steel,**
Below Grade	**PVC, PVC Coated Galvanized Steel**
Grounding Conductor	**PVC**
Fire Alarm – Indoor use	**Red Fire Alarm EMT**

PART 2 -PRODUCTS

2.1 NON-METALLIC CONDUIT

A. Rigid Polyvinyl Chloride (PVC) Conduit:
1. Provide high impact PVC conduit conforming to the requirements of NEMA TC 2 at 90 degrees Celsius, and made from compounds conforming to the requirements of ASTM D 1784.
2. Provide PVC conduits that are UL listed and labeled for use as electrical raceway.
3. Unless otherwise noted on the Contract Drawings PVC conduit shall be Schedule 40.

B. Manufacturers:
1. Carlon
2. Cantex
3. PW Eagle
4. Approved equal.

C. Non-Metallic Conduit Solvent:
1. Provide solvent for non-metallic conduit joints from the same manufacturer as the conduit and conforming to the requirements of ASTM D 2564.

2.2 METALLIC CONDUIT

A. Electrical Metallic Tubing (EMT):
1. Provide electrical metallic tubing (EMT) conforming to the requirements of NEC Article 358 for materials and uses, ANSI C80.3 and UL 797.
2. Provide galvanized steel tubing conduit lengths bearing the manufacturer’s trademark.
3. Electrical Metallic Tubing for use with fire alarm system wiring shall be factory colored red.

B. Manufacturers:
1. Tyco/Allied Tube and Conduit
2. Wheatland Tube Company

3. Western Tube & Conduit Corporation
4. Approved equal.

2.3 RIGID GALVANIZED STEEL CONDUIT (RMC):

A. Provide rigid galvanized steel conduit (RMC) conforming to the requirements of NEC Article 344 for materials and uses, ANSI C80.1, and UL 6.
B. Fabricate the RMC from mild steel piping, hot dipped galvanized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating.
C. Provide defect free conduit bearing the UL label, and furnished in 10-foot minimum lengths with both ends threaded and one end fitted with a coupling.
D. Provide tapered NTP ¾ inch per foot threads complying with NSI/ASME B1.20.1.
E. Acceptable Manufacturers:
   1. Tyco/Allied Tube and Conduit
   2. Wheatland Tube Company
   3. Western Tube & Conduit Corporation
   4. Approved equal.
   5. American Water does not approve the use of IMC in place of RGS.

2.4 PVC COATED RIGID GALVANIZED STEEL CONDUIT:

A. Provide PVC coated rigid galvanized steel conduit bearing the UL label.
B. Provide base conduit of rigid hot-dip galvanized steel conduit as specified in Paragraph 2.02B.
C. Apply PVC coating in accordance with the following:
   1. Apply a 40-mil thick PVC coating on the outside and a 2-mil thick fusion-bonded blue, red, or green urethane coating on the inside, both coatings conforming to the requirements of NEMA RN 1.
   2. Provide plastic coating of one uniform color on all plastic coated rigid galvanized steel conduit provided for the Contract.
   3. Provide 40-mil thick plastic sleeves to protect internally threaded conduit openings.
   4. Provide sleeves with an inside diameter equal to the outside diameter of the conduit/pipe protected by it; and extending either one pipe diameter or 2-inches, whichever is less, beyond the opening.
D. Manufacturers:
   1. OCAL
   2. Perma-Cote
   3. Plasti-Bond
   4. Approved Equal

2.5 FLEXIBLE METAL CONDUIT (FMC)

A. Provide steel flexible metal conduit conforming to the requirements of NEC Article 348.
B. Provide conduit with interlocking spiral galvanized steel strip construction capable of bending to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.
C. Finish the interior and exterior of flexible conduit smooth and free from burrs, sharp edges, and other defects that may injure wires; and place the manufacturer’s trademark on each length.
D. Acceptable Manufacturers
   1. Electri-Flex Company, Type BR
   2. Eastern Wire, Greenfield
   3. Southwire, Type Galflex
   4. Approved equal.

2.6 LIQUIDTITE FLEXIBLE METAL CONDUIT (LFMC)

A. Provide PVC coated flexible metal conduit conforming to the requirements of NEC Article 350 for materials and uses and ANSI/UL 360.

B. Provide conduit with interlocking spiral strip construction capable of bending to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.

C. Provide conduit with a flexible, galvanized, interlocking spiral strip steel core jacketed with smooth, liquid-tight polyvinyl chloride designed to withstand temperatures from minus 40 degrees Celsius to plus 60 degrees Celsius.

D. Finish the interior and exterior of flexible conduit smooth and free from burrs, sharp edges, and other defects that may injure wires; and place the manufacturer's trademark on each length.

E. Furnish an integral continuous copper ground in ½-inch through 1-1/4-inch PVC coated flexible metal conduit.

F. Acceptable Manufacturers
   1. Electri-Flex Company, Liquatite Type LA
   2. ANAMET Electrical, Inc, Sealtite Type UA
   3. Southwire, Titan Type UL
   4. Approved equal.

2.7 CONDUIT FITTINGS

A. Fittings for Non-Metallic Conduit Systems:
   1. Provide high impact non-metallic fittings conforming to same requirements as for the non-metallic conduit as specified in paragraph 2.01.

B. Non-Metallic Conduit Expansion Fittings:
   1. Provide a two-piece nonmetallic, noncorrosive, nonconductive, UL listed expansion fitting.

C. Acceptable Manufacturers:
   1. Carlon
   2. Cantex
   3. PW Eagle
   4. Approved equal.

2.8 FITTINGS FOR METALLIC CONDUIT SYSTEMS:

A. Construct conduit bodies/fittings from cast malleable iron.

B. For PVC coated raceway systems, provide PVC coated fittings of cast malleable iron from the same manufacturer that provides the uncoated conduit bodies/fittings.

C. Conduit Bodies:
   1. Provide malleable iron threaded entry type conduit outlet bodies with neoprene gaskets and cast steel conduit.

D. Acceptable Manufacturers:
   1. Appleton Electric
   2. O-Z/Gedney
   3. Crouse Hinds
   4. Approved equal.

2.9 CONDUIT UNIONS:

A. Provide conduit unions capable of completing a conduit run with threaded connections when neither conduit end can be turned.

B. Acceptable Manufacturers:
   1. Appleton Electric, UNF and UNY Unions,
   2. Thomas and Betts Company, Erickson® Coupling.,

3. OZ Gedney
4. Approved equal.

2.10 CONDUIT OUTLET BOXES:

A. Provide malleable or cast iron conduit outlet boxes conforming to the requirements of UL 886, and having a cover with O-rings to keep out moisture.

B. Acceptable Manufacturers:
1. Appleton Electric, GRF outlets and covers
2. O-Z Gedney
3. Crouse Hinds
4. Approved equal.

2.11 CONDUIT DEVICE BOXES:

A. Provide malleable iron conduit device boxes with internal grounding screws and conforming to the requirements of UL 498 and UL 514A.

B. Acceptable Manufacturers:
1. EGS/Appleton Electric
2. EGS/O-Z Gedney
3. Crouse Hinds
4. Approved equal.

2.12 FITTINGS FOR ELECTRICAL METALLIC TUBING (EMT)

A. EMT couplings and fittings shall be steel compression type.

B. EMT couplings shall be stamped steel.

C. EMT fittings shall be provided with insulated throats.

2.13 BUSHINGS

A. Insulated bushings for conduits 1-1/4 inches trade size and larger shall have metal bodies and threads, with molded high impact thermosetting insulation to prevent conductor damage. Bushings shall be O.Z. Gedney Type IBC or approved equal. Insulated bushings for conduit trades size 1-inch and smaller may be plastic, O.Z.Gedney Type A.

B. Insulated grounding bushings shall be similar to the bushings describe above, except provided with set screws to lock the bushing on the conduit and shall have mechanical type lugs for attachment of the bonding jumper, O.Z. Gedney Type BLG or approved equal.

2.14 HUBS

A. Water tight conduit connections for NEMA 3R, 4 and 4X enclosures shall be stainless steel Myers 'Scru-Tite' or approved equal.

2.15 CONDUIT STRAPS

A. Conduit straps shall be malleable iron and provided with conduit spacers. When installed with PVC coated conduit, the conduit straps shall be PVC coated.

2.16 SMALL SHEET METAL BOXES

A. Pull and terminal boxes for general purpose dry locations:
1. Provide sheet steel boxes with continuously welded seams, ground smooth, no holes or knockouts.
2. Provide overlapping sheet steel screw cover with captivated screws.
3. Provide ANSI Z55.1 No. 61 gray polyester powder coating over phosphatized surfaces.

4. Conform to NEMA 250 Type 1 unless otherwise shown on the Contract Drawings.
5. Outlet Boxes (Concealed- stud wall and above ceilings)
6. Stamped steel, Raco or equal

B. Enclosures for Outdoor Locations:
1. Provide stainless steel boxes with continuously welded seams, ground smooth, no holes or knockouts.
2. Provide seamless drip-shield on top.
3. Provide slip-on cover with stainless steel captivated screws.
4. Provide oil resistant gasket.
5. Conform to NEMA 250 for Type 4X enclosures.
6. Boxes for use with fire alarm system wiring shall be factory or shop painted red.

C. Manufacturers
1. Hoffman
2. Rittal
3. Milbank Manufacturing
4. Approved Equal

2.17 CONDUIT SPACERS

A. For underground conduit installation provide non-metallic, interlocking type conduit spacers which snap together to join any combination of intermediate and base units together, both vertically and horizontally.

B. Manufacturers:
1. Underground Devices Inc.
2. The George-Ingraham Corp.
3. IPEX Electrical
4. Approved equal.

2.18 WIREWAYS

A. Provide wireways including supports, fittings, and accessories necessary as indicated.

B. Provide wireways/troughs of sheet metal for installations of individually mounted motor starters, disconnect switches or for other raceway applications in lieu of conduit where field conditions dictate.

C. Provide surface wireway containing receptacles on fixed spacings for use over desks, workbenches, or lab benches as indicated.

D. Provide wireways/troughs - Constructed in accordance with UL Standards No. 870 for Electrical Wireways, Auxiliary Gutters and Associated Fittings for sizes as noted on the drawings or per NEC. Hinged covers, knockouts and suitable for "lay-in" conductors. Metal parts rust inhibiting phosphatic coated and baked enamel finish. Hardware plated to prevent corrosion and all screws installed toward the inside protected by spring nuts or otherwise guarded to prevent damage to wire insulation. NEMA 1 indoors, 3R outdoors or damp locations.

E. Provide Multi-Outlet Raceways - types and sizes with outlets provided as shown on the drawings manufactured by Wiremold, Inc. or approved equal.

2.19 PENETRATIONS

A. Penetrations through walls, floor slabs and partitions shall be accomplished by using threaded conduit sleeves. Provide nipples or sleeves where prepared slots are not provided, prior to concrete placing, or core drill concrete as required. Prior to core drillings, submit a dimensioned sketch indicating the proposed penetration locations for approval by the Architect/Engineer.

B. Escutcheon plates shall be installed on all exposed conduit penetrations through the ceilings, wall, and floor into finished areas.

C. Approved expansion fittings shall be used wherever conduit crosses the expansion joints shown

on the architectural drawings. Expansion fittings shall be furnished with a suitable bonding jumper.

D. Where conduit is installed between areas of different temperature such as between the interior and exterior of the building, the conduit shall have approved drain fittings installed so as to prevent moisture passage between spaces of different temperature.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. Install in accordance with the applicable provisions of the National Electrical Code, manufacturer's recommendations and the drawings.

B. Make final field measurements prior to release for fabrication to assure coordination with other trades.

3.3 CONTINUITY AND GROUNDING

A. Fasten all conduits to each adjacent section and to all boxes, fittings, and equipment with firm clean metallic contact so that the entire conduit system is well and continuously grounded.

3.4 LOCATION OF CONDUIT AND OUTLETS

A. Run conduit and install outlets carefully and coordinate with other trades to avoid piping, ducts, and mechanical equipment. Do not cross pipe shafts or ventilation duct openings. Maintain adequate vertical and horizontal clearance from piping and minimum clearance under all projections should be 10'-0" above finished floor.

3.5 BUSHING AND LOCKNUTS

A. Provide insulating bushings or connectors on all conduits. Install capped bushings on all conduits as soon as installed and remove only when wires are pulled. Conduit terminations in sheet metal enclosures and outlet boxes shall be secured by two locknuts, one on the inside and one on the outside. Provide an insulating bushing for each conduit or flexible conduit where entering a panel, pull box or outlet box.

3.6 RACEWAYS

A. Install raceways from box or terminations as shown on the drawings or as required to effect circuiting described with circuit numbers adjacent to equipment. Grouping home runs or combining wires in common raceways will be allowed, with a maximum of four single pole branch circuits in a raceway. Increase wire sizes and raceways where required to avoid loss of ampacity as required by National Electrical Code.

3.7 CONDUIT OR CABLE IN HUNG CEILING

A. Run conduit and/or cable on and secure to the slab or primary structural members of ceiling, not to suspension channels, T-bars, Z-bars, or other elements that are the direct supports of the ceiling panels. Secure conduit firmly by clips and fittings designed for that purpose.

3.8 EXPOSED CONDUIT

A. Run conduit parallel or at right angle with building lines. Secure conduit to masonry material with toggle bolts, expansion bolts, or steel inserts. Do not install conduit on steel construction.

B. Conduit and wiring for switches, fire alarm devices, receptacles, or electric door hardware shall not be run exposed in offices, corridors, conference room or any finished space where gypsum board wall construction exists. For gypsum board wall construction, all circuit wiring shall be concealed within wall.

C. Two piece conduit straps with protruding bolt shall not be used to support conduits below 7’-0” AFF for either vertical or horizontal conduit runs. Conduit shall be supported by single or two hole steel conduit straps, conduit shall be offset at box to run flush to the wall.

3.9 CONDUIT SPACING

A. Maintain at least 1/4" air space between conduit and supporting wall. Conduit supports shall not be spaced further apart than permitted by NEC. Conduit shall not be supported by wires or from pipes, mechanical equipment and other conduits. Set anchors for supporting exposed conduits on waterproofed walls with waterproof cement.

3.10 CLEANING OF CONDUIT

A. Clear conduit of all obstructions and dirt prior to pulling in wires or cables.

END OF SECTION 26 05 33

SECTION 260536- CABLE TRAY FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The Work specified in this Section consists of furnishing and installing cable trays and fittings.
B. Related Sections:
   1. The requirements of Section 260503, Electrical Related Work including all related sections apply to the Work of this Section.

1.2 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
B. NEMA VE-1-Metal Cable Tray Systems
C. NEMA VE-2-Metal Cable Tray Installation Guidelines
D. National Fire Protection Association (NFPA):
E. NFPA 70-National Electrical Code (NEC).

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.
B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.
C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   1. Cable Tray
   2. Fittings
   3. Accessories
D. Shop Drawings:
   1. Bill of materials: Provide list indicating manufacturer and catalog number for all items other than standard hardware.
   2. Overall plan of cable tray installation drawn to a scale of 1/4 inch or larger.
   3. Structural calculations: Provide structural calculations for all supports
E. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.
F. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.4 QUALITY ASSURANCE

A. Refer to Section 260503 Electrical Related Work.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 260503 Electrical Related Work.

PART 2 - PRODUCTS

2.1 METALLIC CABLE TRAY SYSTEMS

A. Acceptable Manufacturers:
   1. Provide products of a single manufacturer for metal framing systems and fittings for metal framing systems. Acceptable manufacturers:
      a. B – Line.
      b. Legrand/PW
      c. T. J. Cope
      d. Approved equal
      e. General:

B. Cable trays, covers, fittings, splice plates, and all items shall be 6063T-6 aluminum alloy finished in its natural state.

C. Cable trays must be UL listed for use as a grounding means.

D. Cable trays shall conform to NEMA Standard VE-1 and NFPA 70 Article 392.

E. Furnish all items to provide a complete cable tray system. Include all straight run trays, elbows, tees, vertical curves, fittings, splice plates, bonding material, related support items, and related accessory items required for a complete installation.

F. Provide smooth edges and radius on side rails and rungs to protect cables from damage.

G. Provide tray splice plates of sufficient high strength to carry the same bending moments and shear loads as the cable tray. Provide spliced shoulder bolts to both fully engage the splice plate and the side rail. Provided locknut shall be of the serrated flange type allowing for one-wrench installation.

H. Strength: The cable tray shall be capable of carrying a uniformly distributed cable load specified in NEMA VE-1 for the class of cable tray indicated.

I. Provide elbows, tees, and cross fittings without tangents beyond the point of curvature. Provide fittings with minimum radius that exceeds the minimum cable bending radius.

J. Accessories: Cable tray system shall include all related accessory items such as dropouts, end plates, and barrier strips to separate services in the trays. Covers shall be furnished where indicated on the Contract Drawings.

2.2 LADDER TYPE CABLE TRAY

A. Provide ladder type cable of class, types and sizes as indicated.
   1. Rail Height……..5 inches
   2. Loading Depth……4 inches
   3. Rung Spacing……..6 inches
   4. Loading……50 lbs/ft
   5. Support Spacing……8 feet
   6. Tray Width……As shown on Contract Drawings
   7. Midspan Defection……1/200 of span

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 PREPARATION

A. Carefully investigate the structural and finish condition as well as other construction work, which may affect the work of this Section.

B. Field Measurement: The Drawings are generally indicative of the work but due to their small scale it is not possible to indicate all offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered. Make field measurements of the areas in which cable tray is to be installed.

C. Carefully investigate the structural and finish condition as well as other construction work, which may affect the work of this Section. Arrange electrical work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment. Layout cable tray to suit actual field measurements.

3.3 INSTALLATION

A. In general, fabricate cable tray systems in accordance with accepted Trade standard practice and NEMA VE-2.

B. Provide fire stopping of penetrations through fire rated assemblies as indicated on the Contract Drawings.

C. Make all field cuts using power hacksaw equipped with both a table for supporting the cable tray and a means of holding the tray rigidly in place and making a clean square cut. Drill all holes using a drill press and templates to accurately locate splice plate holes. Equivalent means and methods, which produce accurate clean cuts and holes, are acceptable. Ends must be square to within 1/16-inch and holes located to within 1/32-inch of nominal. Center punch all hole locations. Use pilot holes as necessary. File off all burrs and rough edges.

D. Install all items in strict accordance with manufacturer's instructions; in conformity with any product listing and labeling restrictions and instructions; in conformity with NEMA Standard VE-2 and in accordance with NFPA Articles 250, 300 and 318. Provide continuous supplemental grounding conductor size as indicated on the Contract Drawings.

E. Do not weaken the structure by excessive or unnecessary cutting.

F. Provide expansion plates in each straight run and at each building expansion joint.

G. Make conduit drops from cable tray with approved fittings.

H. Construct in exposed work parallel and perpendicular to building lines and structure and level and plumb with right angle turns consisting of symmetrical bends or fittings, except as indicated and as follows. Construct changes in vertical elevation at 45 degrees to the horizontal and construct offsets of less than two medium radius with 30 degree or 45 degree bends. Maintain at least 6-inches clearance between cable tray runs and mechanical systems pipes, ducts, flues.
Provide structural supports conforming to Section 260528 of adequate strength to conform to dead, live and seismic loads to be encountered.

END OF SECTION 260536

SECTION 260548 VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 -GENERAL

1.1 SUMMARY

A. Section Includes: The Work specified in this Section includes furnishing and installing vibration and seismic controls for electrical systems.

1.2 RELATED SECTIONS:

A. The requirements of Section 260503, Electrical Related Work including related sections apply to the Work of this Section.

1.3 REFERENCES

A. International Building Code (IBC)
B. New Jersey Uniform Construction Code (NJUCC)

1.4 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.
B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.
C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
D. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
E. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
F. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.
G. Product Data: Submit manufacturer's technical data for each component of system specified, including product specifications and installation instructions.
    1. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
H. Shop Drawings: Included plans, elevations, sections, details, penetrations, terminations, fasteners and attachments to other work.
I. Samples: for each product provide color and texture samples requested by Architect.
    1. Initial Selection: Submit manufacturer's color sheets and small-scale samples indicating manufacturer's full range of colors and textures for selection by Architect.
    2. Verification: Submit 8-inch x 8-inch samples for each finish, color and texture selected; prepare samples using same tools and techniques intended for actual work.
J. Field quality-control test reports.
K. Product certificates and test reports.
L. Research / evaluation reports.
M. Maintenance data.
N. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
    1. Recycled content – documentation showing product supports pre and post – consumer content.
    2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project

is located.

3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
4. Comply with recycling program and waste management procedures.

O. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
1. Requirements of 017700 CLOSEOUT PROCEDURES;
2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

P. Quality Control Submittals:
1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer indicating compliance with applicable "Qualifications" requirements specified below.
2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with requirements specified below.

1.5 SHOP DRAWINGS

A. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

B. Provide all details of suspension and support for ceiling hung equipment.

C. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details or acceptable attachment methods for ducts and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

D. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

1.6 SEISMIC CERTIFICATION ANALYSIS

A. Calculations by the Manufacturer's qualified licensed Engineer substantiating the mounting system, seismic restraints and recommended anchor bolts shall be submitted along with the shop drawings. Calculations shall be based on the loads as established in the table at the end of this section. All analysis shall be stamped by a registered professional having a P.E. from the same state as the project.

B. Unless otherwise specified, all equipment and conduit shall be restrained to resist seismic forces. Restraints shall maintain equipment or conduit in a captive position. Restraint devices shall be designed and selected to meet seismic requirements as defined in the latest issue of:
1. IBC International Building Code
2. International Building Code Additions: In addition to all of the above provisions, Contractor shall comply with sections 16 and 17 of the International Building Code using only vendors that comply with the provisions stated herein and submitting the special inspections listed within these specifications. Where compliance is not possible, each contractor shall submit a vendor report clearly indicating that none of the specified, listed or other vendors known to the contractors meet the compliance, testing and certification portions of the IBC spec section 16 and 17. Special inspections shall still be conducted even if no vendors meet the enclosed requirements. All non-isolated and isolated equipment, (components) shall be secured to the structure in accordance with that code.

C. All component manufacturers shall submit for approval the following as required below:
1. All life safety system components noted in this specification will have the manufacturer of that

component submit the Approved Agencies Certificate of Compliance for the specific equipment on this project when the Seismic Design Category is "C – F". Analytical or shaker test certification thru the component's load path including structure at its center of gravity shall include anchorage, structural and online capability.

2. All components noted in this specification will have the manufacturer of that component submit the Approved Agencies Certificate of Compliance for their equipment when used on a Seismic Hazard Exposure Group III project when the Seismic Design Category is "C-F". This requirement also pertains to projects that combine an emergency preparedness center within a structure of another Use Group where that component is needed for continued operation of the building or whose failure could impair the continued operation of the building. Note: the definition of the above refers to any component which does not allow or hampers the use or capability of the intended purpose of that structure Analytical or shaker test certification thru the total component's load path to structure at its center of gravity shall include anchorage, structural and on line capability.
3. All components containing hazardous or flammable materials will have the manufacturer of that component submit the Approved Agencies Certificate of Compliance for their equipment when used on any project having a minimum Seismic Design Category of "C-F". Analytical or Shaker Test Certification thru the total component's load path to structure at its center of gravity shall include anchorage and structural capability to insure against loss of hazardous or flammable, (explosive) material.
4. All components that are not listed in the above categories shall have the manufacturers of each component submit a PE stamped calculation package that their project specific equipment will accept anchorage through the component's load path to structure at its center of gravity at the designated anchorage locations. This requirement is for all projects having a Seismic Design Category of (C-F).

D. The following systems shall require Special Inspection and Periodic Special Inspection for anchorage during the course of construction as defined earlier in this section for all buildings in Seismic Design Categories C-F.
   1. All electrical components for standby or emergency power systems require Periodic Special inspection.
   2. Conduit, 3" and larger.
   3. Isolator units for seismic isolation system.

1.7 CONTRACTOR RESPONSIBILITIES AND APPROVALS:

A. Each contractor responsible for the installation of the components above shall be responsible for submitting to the design team for their approval a written contractor's statement of responsibility as outlined below.
   1. Identify the components that are part of the Quality Assurance Plan.
   2. Identify all Special Inspection and Testing.
   3. List control procedures within the contractor's organization including methods and frequency of reporting and their distribution.
   4. List personnel and their qualifications exercising control over the seismic aspects of the project.

1.8 DESIGN LOADS:

A. Projects will have a maximum design load of .4g for statically mounted components and .9g for resiliently mounted components.

B. The minimum horizontal restraint capability shall be 0.4 g horizontal and .27 vertical. Life safety equipment defined above shall be designed to survive a horizontal load of .9g and a vertical load of .6g.

C. Testing or calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered Professional Engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include shear and

tensile loads as well as one test or analysis at 45° to the weakest mode. IBC Component testing must be by an Approved Agency.

D. Analysis for anchorage must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in Section 4 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

E. Vertical load shall be calculated at 2/3 the horizontal load.

F. Internally isolated equipment in lieu of specified isolation and restraint systems must meet the specified isolation and system restraint criteria.

G. A seismic design Errors and Omissions insurance certificate MUST accompany the equipment manufacturer's certification. Product liability insurance certificates are not acceptable.

H. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure. Curb or roof rail mounted equipment must not only have seismic attachment of the equipment to the roof but also to the curb or rails. The attachment and certification thereof shall be by this section.

1.9 RELATED WORK

A. Housekeeping pad design shall be as indicated on the drawings. Attachment shall be designed and certified according to this section by the seismic/isolation supplier. Material and labor required for attachment and construction shall be by the contractor. Housekeeping pads shall be sized to accommodate a minimum of six (6) inches of clearance all around the equipment or 12 times the anchor bolt diameter, whichever is greater and its mounting package. Structural support and connections for all equipment, including roof-mounted equipment, specified in other sections shall comply with all IBC requirements indicating load path to the structure.

B. Lay-in ceilings in compliance with seismic zone requirements may use earthquake clips or other approved means of positive attachment to brace fixtures such as lights and diffusers less than 75 pounds to T-bar structures. Local codes dictate support requirements.

1.10 QUALITY ASSURANCE

A. Refer to Section 260503, Electrical Related Work

1.11 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 260503, Electrical Related Work

1.12 MANUFACTURER'S RESPONSIBILITY

A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:

B. Determine vibration isolation and seismic restraint sizes and locations.

C. Provide vibration isolation and seismic restraints as scheduled or specified.

D. Provide calculations and materials if required for restraint of unisolated equipment.

E. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

F. Certify correctness of installation upon completion.

G. All provisions of section 1.05.B.3. Seismic Certification & Analysis.

H. All manufacturers providing equipment and/or vibration/seismic control systems must provide a Seismic Design Error and Omissions Insurance Certificate for their firm or their design consultant to certify their ability to provide engineering and design as required by this Section.

PART 2 -PRODUCTS

2.1 DESCRIPTION

A. All vibration isolation and seismic devices described in this section shall be the product of a single manufacturer.

B. Design of hardware and devices such as beam clamps, anchor bolts, cable and cast-in-place plates must be by this section's supplier to ensure seismic compliance and certification. The contractor has the option to utilize alternate fastening devices (anchor bolts) so long as the sizing and dimensions on seismic submittals are followed.

C. Unless otherwise specified, all isolator hardware shall be zinc plated. Springs with a deflection of up to 2 inches shall be coated with a polyester epoxy powder. Springs and rubber isolators shall be color coded for proper identification of rated load capacity. Zinc plating shall conform at ASTM B633, Class 2 SC2, minimum. All other metal parts used outdoors shall be hot spray or hot dipped galvanized.

1. VIBRATION ISOLATION AND SEISMIC RESTRAINT TYPES

D. DOUBLE DEFLECTION NEOPRENE

1. Double deflection neoprene mountings shall have a minimum rated static deflection of 0.40 inches. Steel top plate and base plate shall be completely bonded and embedded in oil-resistant elastomer. Mountings shall be molded in color for ease of identification of load capacity, and shall have ribbed neoprene surfaces on top and bottom to provide friction pads for those applications, which do not need to be bolted to the floor or to equipment. Bolt holes shall be provided on the bottom plate, and a tapped hole on the top, for applications requiring positive tie down.
2. Acceptable Manufacturers:
    a. Vibration Mountings and Controls, Inc.
    b. Mason Industries.
    c. Vibration Eliminator.
    d. Or approved equal.

E. FLOOR MOUNTED SPRING ISOLATORS

1. Free standing spring-type isolators, shall be laterally stable without housing, snubbers, or guides, and shall include a steel reinforced, ribbed neoprene cup (¼ inch minimum thickness) between the baseplate and the support. Mountings shall have leveling bolts on the top, consisting of an adjusting bolt, cap screw and washer. Mountings shall include a bolt hole in the bottom cup or a two hole rectangular steel baseplate for bolting to the structure.
2. Springs shall not be welded to the baseplate or cup. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection.
3. Acceptable Manufacturers:
    a. Vibration Mountings and Controls, Inc.
    b. Mason Industries.
    c. Vibration Eliminator.
    d. Or approved equal.

F. HOUSED SPRINGS WITH LIMIT STOPS

1. Free standing, laterally stable spring type isolators. Isolator is the same as described in Specification 2.02.B, except that it includes a housing to provide vertical limit stops to prevent spring extension during weight changes, or when equipment is exposed to uplift loads such as wind loading. The housing serves as blocking during erection, and shall be located between the equipment and supporting structure. There shall be a minimum clearance of ¼" between the restraining bolts and the housing and spring to prevent interference with spring performance. Limit stops shall be out of contact during normal operation. Mountings shall have an adjusting bolt on the top of the spring compression plate. For non-seismic applications, neoprene acoustical non-skid pads (¼ inch minimum thickness) shall be attached to the bottom plate. When used in seismic applications, neoprene bushings shall be incorporated in the limit stop plate. Spring

diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection. Springs shall not be welded to the cups or housings.

2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

G. COMBINATION SPRING/RUBBER ISOLATION HANGERS

1. Spring-Flex hangers shall consist of a steel spring in series with a .2 inch (minimum) deflection neoprene element. Springs shall be color coded, and elastomer element molded in specific colors for proper identification of rated load capacity. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Pipe isolators shall have spring diameters and hanger box lower hole sizes of sufficient size to permit the hanger rod to swing approximately 30° before contacting the box. Hangers which are to be used with flat iron duct straps will be provided with eye bolts on both ends.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

H. SPRING/RUBBER PRE-POSITIONING HANGERS

1. Spring-Flex hangers shall consist of color-coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Hanger design shall incorporate a means for supporting the suspended equipment or piping at a fixed elevation during installation regardless of load changes as well as a means for transferring the load to the spring.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

I. PRE-COMPRESSED HANGERS

1. Spring-Flex hangers shall consist of a color-coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Springs shall be pre-compressed to the rated deflection so as to support the suspended equipment or piping at a fixed elevation during installation regardless of load changes. For 30° misalignment capability, spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30° before contacting the box.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

J. SPRING HANGERS

1. Spring-Flex hangers shall consist of a color-coded steel spring with a neoprene and steel washer, which will properly distribute the load on the spring. For 30° misalignment capability, spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30° before contacting the box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers, which are to be used with flat iron duct straps will be provided with eye bolts on both ends.
   a. Acceptable Manufacturers:
   b. Vibration Mountings and Controls, Inc.

c. Mason Industries.
d. Vibration Eliminator.
e. Or approved equal.

K. SELF-ALIGNING SPRING HANGER
1. Spring-Flex hangers shall consist of a color-coded steel spring seated in a neoprene spring cup with integral bushing to insulate the lower support rod from the hanger box. The steel hanger box shall be hinged to allow for a minimum of 30° misalignment between the rod attachment to structure and the connection to the supported equipment. Hanger boxes shall withstand three times the rated load without failure.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

L. FLOOR, WALL, AND CEILING SLEEVES
1. Where piping passes through walls, floors, or ceilings, a vibration control sleeve shall be provided to reduce the transmission of vibration. The sleeve shall consist of two pipe halves with neoprene sponge material bonded to the inside and a bolting arrangement for secure fit around piping. Where temperature exceeds 240°F, an appropriate density fiberglass shall be used in place of neoprene material.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

M. SEISMIC SPRING MOUNTINGS
1. Steel spring isolator incorporating elastomeric snubbing in all directions. The snubber shall be adjustable in the vertical direction and allow a maximum of ¼" travel in all directions before contacting the elastomer cushion. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection. Housing shall have provision to adjust the rebound plate and to inspect the spring. Housing shall be of cast ductile iron, malleable cast iron or of welded steel construction. Gray iron castings are not permitted. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

N. SEISMIC SNUBBERS/RESTRAINTS
1. All-directional seismic snubbers shall include all directional elastomer elements, having a minimum elastomer thickness of ¾" in all directions. Elastomers shall be easy to inspect and shall consist of replaceable elastomer inserts. Elastomer shall be neoprene or a high quality rubber including anti-ozone and anti-oxidant materials and conform to ASTM D2003 Grade 2BC or Bridge Bearing Neoprene. Snubbers shall be manufactured with an air gap between steel and elastomer of 1/8 inch to ¼ inch. Snubbers shall be installed with factory set clearances. Snubber must have at least two anchor bolt holes and shall have an ultimate load capacity of at least four times the rated static load capacity.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.

c. Vibration Eliminator.
d. Or approved equal.

O. CABLE RESTRAINTS/SINGLE ARM BRACE
1. Steel aircraft cable restraints are designed and installed to limit motion on suspended isolated equipment, piping or ducting. Cable are installed with enough slack to engage only when ¼ inch movement occurs. On suspended equipment, cables are installed in sets of four, located at 45° angles to all three axes. Where required at pipe hangers, cables are placed two at each location, alternating orientation at successive locations. Cable shall be 7x19 galvanized or stainless steel aircraft cable conforming to FED-STD-RR-W-410D.
2. Non-isolated equipment, pipe, and duct shall be seismically restrained with the use of a rigid brace consisting of two steel brackets designed to accept a steel angle or unistrut. Brackets shall provide easy installation by allowing full range of motion in horizontal and vertical directions. Rigid braces with slotted holes or hinges are not acceptable.
3. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

P. CAPTIVE ELASTOMER MOUNTINGS
1. Consist of a captive elastomeric mount molded from neoprene or EPDM compound conforming to the requirements of ASTM D2003. Load bearing elastomer element shall be housed in a cast ductile iron housing. Mount shall incorporate a fail-safe captive design, and shall provide a vertical natural frequency of approximately 8 Hz at rated static load. Mount shall be capable of providing dynamic deflections of up to .5 inches.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

Q. STRUCTURAL BASES
1. Integral structural steel bases shall be rectangular in shape. All structural members shall be of wide flange, angle or channel steel with depth equal to a minimum of 1/10 of the longest span of equipment, but not less than 6 inches. Built-in adjustable motor slide rails and height saving brackets shall be supplied as in integral part of the base.
2. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

R. STRUCTURAL RAILS
1. Rails for indoor applications or outdoor applications where equipment supports are mounted on isolation systems shall be of wide flange, angle or channel steel with depth equal to a minimum of 1/10 of the longest span of equipment, but not less than 6 inches. Height saving brackets shall be supplied as an integral part of the rails. For seismic applications rails must be structurally attached to one another.
2. Rails for outdoor applications where weatherproofed isolated equipment supports are required, shall be a continuous structural support rail that combines equipment support and isolation mounting into one unitized assembly. Rails shall incorporate roof-enclosed springs, which are adjustable, removable and interchangeable, after equipment has been installed. The system shall maintain the same installed and operating height with or without the equipment load and shall be capable of being utilized as a blocking device. The entire assembly shall be an integral part of the roof's membrane waterproofing. Unit to be supplied with continuous upper and lower galvanized

flashing. Rails shall be cross-braced at support and equipment attachment points when used in seismic zones. Rails shall be bolted or welded to the building steel or anchored to the concrete deck to attain specified acceleration criteria.

3. Acceptable Manufacturers:
   a. Vibration Mountings and Controls, Inc.
   b. Mason Industries.
   c. Vibration Eliminator.
   d. Or approved equal.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 GENERAL

A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment or conduit resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The contractor shall not install any isolated equipment, which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. General bracing may occur from flanges to structural beams, upper truss cords in bar joist construction and cast in place inserts or wedge type drill-in concrete anchors.

G. Seismic cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment.

H. Seismic cable assemblies are installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems except where single arm braces incorporate resilient bushings.

I. At locations, where seismic cable restraints or seismic solid braces are located, the support rods must be braced when necessary to accept compressive loads.

J. At all locations where seismic cable braces and seismic cable restraints are attached to pipe clevises, the clevis bolt must be reinforced with pipe clevis cross bolt braces or double inside nuts if required by seismic acceleration levels.

K. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted.

L. Where piping passes through walls, floors or ceilings, the contractor shall provide wall seals or resilient

packed pipe sleeves.

M. Special & Periodic Inspections for items listed in Section 1.03 (Article #4) shall be conducted and submitted on a timely basis.

3.3 EQUIPMENT INSTALLATION

A. Equipment shall be isolated and restrained as follows:
   1. The following equipment shall be vibration isolated:
   2. Engine-generator sets.
   3. Transformers.
   4. Uninterruptible power supplies.
   5. All floor-supported equipment shall be seismically braced.
   6. All ceiling suspended equipment shall be seismically braced.
   7. All wall-mounted equipment shall be seismically mounted.
   8. All conduit, cable tray, bus duct and wireway shall be seismically braced.

B. Place floor mounted equipment on 4" high concrete housekeeping pads properly doweled or expansion shielded to the deck to meet acceleration criteria. Anchor isolators and/or bases to housekeeping pads. Concrete work is specified under Division 2.

3.4 ADDITIONAL REQUIREMENTS:

A. The minimum operating clearance under bases shall be 2".

B. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.

C. The equipment shall be installed on blocks to the operative height of the isolators. After the entire installation is complete, and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolation. The equipment shall be free in all directions.

D. Ceilings containing diffusers must meet seismic zone requirements by using earthquake clips or other approved means of positive attachment to secure diffuser to T-bar structure.

E. All floor or wall mounted equipment shall be restrained.

3.5 SEISMIC RESTRAINT OF PIPING, CONDUIT, BUS DUCT AND CABLE TRAY

A. All high hazard and life safety pipe regardless of size such as fuel oil piping shall be seismically restrained. Seismic cable restraints or seismic solid braces may be used. There are no exclusions for size or distance for this category.

B. Seismically restrain all conduit seismic cable restraints or seismic solid braces may be used on unisolated conduit.

C. See the below Table for maximum seismic bracing distances.

TABLE A
SEISMIC BRACING TABLE
ON CENTER SPACING

Equip	**Transverse**	**Longitudinal**	**Within Each Change Of Direction (Larger of)**
Conduit	40 Feet	80 Feet	10 Ft or 15 Diameters
Bus Duct	20 Feet	40 Feet	4 Feet
Cable Tray	40 Feet	80 Feet	10 Feet

D. Multiple runs of conduit on the same support shall have distance determined by calculation.
E. Rod braces shall be used for all rod lengths greater than 3'.
F. Clevis hangers shall have spacer placed inside of hanger at seismic brace locations.
G. Transverse restraint for one conduit section may also act as a longitudinal restraint for a conduit section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.
H. Hold down clamps must be used to attach conduit to all trapeze members before applying restraints.
I. Branch lines may not be used to restrain main lines.

3.6 INSPECTION

A. All independent Special and Periodic Inspections must be performed and submitted on as outlined in Section 1.
B. Upon completion of installation of all vibration isolation devices, the local representative shall inspect the completed project and certify in writing to the Contractor that all systems are installed properly, or require correction. The Contractor shall submit a report to the Architect, including the representative's report. Certifying correctness of the installation or detailing corrective work to be done.

END OF SECTION

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 -GENERAL

1.0 SUMMARY

A. Section Includes: The Work specified in this Section includes furnishing and installing nameplates, tags and signs for identification of electrical systems.

1.1 RELATED SECTION:

A. The requirements of Section 260503 Electrical Relate Work including related sections apply to the Work of this Section

1.2 REFERENCES

A. American National Standards Institute (ANSI):
B. ANSI Z535.4, Product Safety Signs and Labels.
C. National Electrical Manufacturer's Association (NEMA):
D. NEMA 250, Enclosures for Electrical Equipment.
E. National Fire Protection Association (NFPA):
F. NFPA 70, National Electrical Code (NEC).
G. NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces.
H. U. S. Government:
I. Code of Federal Regulations (CFR)
J. 29 CFR 1910 Occupational Safety and Health Standards.

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.
B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.
C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
D. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.
E. Product Data: Submit manufacturer's technical data for each component of system specified, including product specifications and installation instructions.
    1. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
F. Shop Drawings: Included plans, elevations, sections, details, penetrations, terminations, fasteners and attachments to other work.
G. Samples: for each product provide color and texture samples requested by Architect.
    1. Initial Selection: Submit manufacturer's color sheets and small-scale samples indicating manufacturer's full range of colors and textures for selection by Architect.
    2. Verification: Submit 8-inch x 8-inch samples for each finish, color and texture selected; prepare samples using same tools and techniques intended for actual work.
H. Field quality-control test reports.
I. Product certificates and test reports.
J. Research / evaluation reports.

K. Maintenance data.
L. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post – consumer content.
   2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.
M. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES;
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.
N. Quality Control Submittals:
   1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer indicating compliance with applicable “Qualifications” requirements specified below.
   2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner’s contact and telephone number for each project, demonstrating compliance with requirements specified below.

1.4 SHOP DRAWINGS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.
B. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.

1.5 QUALITY ASSURANCE

A. Refer to Section 260503 Electrical Related Work.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 260503 Electrical Related Work.

PART 2 -PRODUCTS

2.0 MANUFACTURERS

A. Provide products meeting the specified requirements from one of the following manufacturers, unless otherwise indicated:
   1. Brady Corporation
   2. Seton Identification Products
   3. LEM Products
   4. Approved Equal

2.1 MATERIALS

A. Laminated Phenolic or Plastic:

1. Provide rigid, thermosetting resin or polymer material that is heat- and fire-resistant, abrasion resistant, electronically non-conductive, and non-corroding.
2. Extrude the thermosetting resin or polymer into sheets, and laminate the sheets together so that colored top and bottom layers sandwich a contrasting color core in the middle.

2.2 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Provide laminated phenolic or plastic equipment identification nameplates having beveled edges and engraved lettering.

B. Drill holes for mounting hardware in the equipment identification nameplates as follows:
1. For nameplates that are more then 2 inches wide, drill four holes.
2. For nameplates that are more than 1-1/2 inches high, drill four mounting holes.
3. For smaller nameplates, drill holes for two fasteners.

C. Provide equipment identification nameplates long enough to ensure that the heads of fastening hardware do not extend beyond the nameplate material, and come no closer than 1/16-inch to the nearest letter of the nameplate legend and no closer than 1/16-inch to the nearest edge.

D. Provide nameplates for all electrical equipment including but not limited to panelboards, switchboards, transfer switches, disconnect switches, starters, cabinets, transformers and UPS equipment.

E. In the first line, indicate the equipment name and identification number.

F. In the second line, indicate the equipment voltage, the phases, and the number of wires.

EXAMPLE 1: Panelboard

PANELBOARD PPB-2
208Y/120 VOLTS, 3-PHASE, 4-WIRE

EXAMPLE 2: Motor Disconnect Switch

RETURN PUMP
RP-350
480 VOLTS

G. Engrave equipment identification nameplates with all capital, Helvetica Medium font, or equal, lettering.

H. Provide black nameplate lettering centered on white backgrounds, except for warning nameplates provide white lettering centered on red backgrounds.

I. Provide a minimum 1/8-inch border between the nameplate lettering and the tops and bottoms of the nameplates.

J. Use 3/8-inch high letters for the first line, and 1/4-inch letters for succeeding lines; except, in cases where the tag will not fit because the equipment is too small, use 3/16-inch letters for the first line and 1/8-inch letters for succeeding lines.

2.3 CONDUIT AND RACEWAY LABELS

A. Conduit Wiring System Identification:
1. Mark all pull and junction boxes with the panel and circuit number of the conductors contained in the enclosure.

2.4 ARC-FLASH WARNING LABELS:

A. Provide Arc Flash Warning Labels in accordance with NEC Article 110.16.

2.5 AVAILABLE FAULT CURRENT

A. The service equipment shall be legibly marked with the maximum available fault current in accordance with NEC Article 110.24

PART 3 -EXECUTION

3.0 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.1 INSTALLATION

A. Wiring Identification:
   1. Identify all power and control wiring in accordance with Section 260519.
   2. Identify all voice and data wiring in accordance with Communication section

B. Convenience Receptacles:

C. Provide self adhesive vinyl labels indicating the panel and circuit number serving the device.

D. Verify that the equipment listed in Paragraph below is being provided under the Contract, or delete those items not being provided here and in the Related Sections above.

E. Electrical Equipment Identification:
   1. Provide identification nameplates for electrical equipment including but not limited to:
      a. Generator
      b. Dry Type Transformers
      c. Surge Protective Devices (SPD).
      d. Uninterruptable Power Supply
      e. Enclosed circuit breakers
      f. Service Disconnecting Means
      g. Transfer Switches
      h. Low-voltage motor starter switches and Controllers
      i. Variable Frequency Controllers
      j. Low-voltage Enclosed Contactors
      k. AC Distribution Switchboards

F. Panelboards

G. Distribution Panels

H. Motor Disconnect Switches

3.2 INSTALL NAMEPLATES IN THE TOP CENTER OF THE FRONT FACE OF THE ELECTRICAL EQUIPMENT IN A VISIBLE LOCATION.

A. For NEMA 1 and NEMA 12 enclosures constructed as specified in NEMA 250, fasten the nameplate to the enclosure using 316 stainless steel screws or an approved equal.
B. For other than NEMA 4X enclosures provide adhesive backed labels.

END OF SECTION 26 05 53

SECTION 26 05 73 - SHORT-CIRCUIT AND COORDINATION STUDY

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall furnish a short circuit and protective device coordination studies as prepared by the equipment manufacturer.

1.2 RELATED SECTIONS

A. Section 26 22 13 Transformers
B. Section 26 24 16 Panelboards
C. Section 262913 Motors and Motor Starters
D. Section 262313-Natural Gas Engine Alternator Set

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE 141 - Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
   2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   3. IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis
   4. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings
   5. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

B. American National Standards Institute (ANSI):
   1. ANSI C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
   2. ANSI C37.13 - Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
   3. ANSI C37.010 - Standard Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
   4. ANSI C 37.41 - Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
   5. The National Fire Protection Association 70, National Electrical Code, latest edition.

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be performed on the entire electrical distribution system, and a report be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
B. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short circuit and coordination studies shall be summarized in a final report. Five (5) copies bound copies of the complete final report shall be submitted. For large system studies with submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short circuit input and output data.
B. The report shall include the following sections:

1. One-line diagram.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Recommendations for system improvements, where needed.
7. Executive Summary.

1.6 QUALIFICATIONS

A. The short circuit, coordination, and arc flash studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be registered in the state of New Jersey, and shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCT

2.1 STUDIES

A. Electrical contractor shall provide short circuit, protective device coordination, and arc flash studies. Electrical contractor shall enlist the services of a qualified engineer to perform studies, and prepare reports.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The engineer performing the short circuit and coordination studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
B. Source combination may include present and future motors and generators.
C. Load data utilized may include proposed loads obtained from Contract Documents provided by Contractor.
D. Include fault contribution of existing motors in the study, with motors < 100 hp grouped together. The Contractor shall obtain required existing equipment date, if necessary to satisfy the study requirements.

2.3 SHORT CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use typical conductor impedances based on IEEE Standards 141-1993.
B. Transformer design impedances shall be used when test impedances are not available.
C. Provide the following:
   1. Calculation methods and assumptions.
   2. Selected base per unit quantities.
   3. One-line diagram of the system being evaluated.
   4. Source impedance data, including electric utility system and motor fault contribution characteristics.
   5. Typical calculations.
   6. Tabulations of calculated quantities.
   7. Results, conclusions, and recommendations.
D. Calculate short circuit momentary and interrupting duties for a three phase bolted fault at each:
   1. Electric utility’s supply termination point.
   2. Incoming switchgear.
   3. Low voltage switchboard.

4. Motor control centers.
5. Standby generators and switchgear.
6. Branch circuit panelboards.
7. Other significant locations throughout the system.
8. The arc flash analysis shall include incident energy and flash boundary calculations.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short circuit study.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short circuit stresses.
3. Adequacy of transformer windings to withstand short circuit stresses.
4. Cable and busway sizes for ability to withstand short circuit heating.
5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:
1. Electric utility's protective device.
2. Low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
3. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
4. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters.
5. Conductor damage curves.
6. Ground fault protective devices, as applicable.
7. Pertinent motor starting characteristics and motor damage points.
8. Pertinent generator short circuit decrement curve and generator damage point.
9. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. The coordination study shall provide recommended settings for all adjustable overcurrent devices to achieve best possible coordination while minimizing the arc flash category. Where arc flash levels exceed Category 2, recommendations shall be made to reduce the arc flash level.

2.5 REPORT SECTIONS

A. Input Data:
1. Short circuit reactance of rotating machines.
2. Cable and conduit materials.
3. Bus ducts.
4. Transformers.
5. Reactors.
6. Circuit resistance and reactive values.

B. Short Circuit Data:

1. Source fault impedance and generator contributions.
2. X to R ratios.
3. Asymmetry factors.
4. Motor contributions.
5. Short circuit kVA.
6. Symmetrical and asymmetrical fault currents.

C. Recommended Protective Device Settings:
   1. Phase and Ground Relays:
      a. Current Transformer Ratio.
      b. Current setting.
      c. Time setting.
      d. Instantaneous setting.
      e. Specialty non-overcurrent device settings.
      f. Recommendations on improved relaying systems, if applicable.
   2. Circuit Breakers:
      a. Adjustable pickups and time delays (Long time, short time, ground).
      b. Adjustable time-current characteristic.
      c. Adjustable instantaneous pickup.
      d. Recommendations on improved trip systems, if applicable.
   3. The contractor shall present a sample arc flash label for approval.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Engineer in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

E. Upon acceptance of the report and label by the Engineer, the contractor shall prepare and install arc flash labels.

END OF SECTION 26 05 73

SECTION 26 08 00 - START-UP AND COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 and Electrical General Provisions sections, apply to work of this section.

1.2 RELATED SECTIONS

A. Related Sections include the following:
B. Section 017839-Project Record Documents
C. Section 017900-Demonstration and Training
D. Section 260516 Wire, Cables and Connectors
E. Section 26 24 16 Panelboards
F. Section 262913 Motors and Motor Starters
G. Section 262313-Natural Gas Engine Alternator Set
H. Section 263353-Static Uninterruptable Power Supply
I. Section 263623-Automatic Transfer Switch
J. Section 265000-Lighting Fixtures and Accessories
K. Section 283111 - Fire alarm system

1.3 INTENT

A. It is the intent of this Section to verify and document the performance of the electrical systems and equipment installed and to ensure their operation in accordance with the design parameters shown on the Drawings and described in the Specifications.

1.4 DESCRIPTION OF WORK

A. The Contractor is required to fulfill all of the requirements specified in this section and related documents.
B. The Contractor shall engage an approved Testing Agency to perform testing and provide reports on test procedures. Testing Agency shall be NETA Accredited, and the technicians performing the testing shall be certified according with ANSI/NETA ETT, Standard for Certification of Electrical Testing Personnel.
C. Testing Agency shall have a in place a calibration program in accordance with NETA-ATS.
D. The Contractor shall coordinate the activities of the Contractor, Testing Agency, subcontractors, equipment manufacturers, Engineer, Owner's personnel and others involved the Commissioning process.
E. All testing shall be performed in accordance to NETA-ATS.
F. The Contractor shall provide a factory authorized technician to assist in start up of all equipment. Technician shall start-up, test and adjust equipment to ensure operation fulfills design intent. Technician shall measure and record the information required to complete the reports specified hereinafter.

1.5 SYSTEMS

A. As a minimum the following systems will require Testing, start-up and commissioning:
   1. Generators
   2. Panelboards and Breakers
   3. Automatic Transfer Switch
   4. Motor Starters
   5. Emergency lighting system
   6. Lighting Controls
   7. Fire Alarm/Detection Systems
   8. Clean Agent Release

9. UPS System

B. In addition, refer to requirements of Division 23 and other Divisions as required. The Electrical Contractor is responsible for assistance in start-up and commissioning of motors and other powered equipment.

C. Electrical contractor shall coordinate the commissioning of the Generator, Automatic Transfer Switch, Lighting Controls, and UPS with the third party commissioning agent. Contractor shall provide a copy of the MOP, and testing procedures for review and approval to the Engineer. Owner, and Commissioning Agent prior to testing.

1.6 DEFINITIONS

A. "Commissioning" is defined as the process of verifying and documenting the performance of systems to ensure their operation in accordance with the design parameters shown on the Drawings or described in the Specifications.

B. "Start-Up" is defined as the moment when the equipment has been fully connected, is ready for operation and is powered up by the Contractor or his representative for testing and adjustment.

C. "Acceptance Test" is defined as testing to be performed to prove the equipment is performing according to specifications, operates properly, and is ready for use by the Owner.

1.7 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.

B. The Contractor shall prepare written procedures for the performance of all testing. The procedures shall include an itemization of all equipment, devices, cable and material requiring field testing, setting, adjustment or calibration and shall describe the required set points.

C. Test Reports: The Contractor shall maintain records for all tests and inspections with complete data on all measurements and observations and prepare and submit reports for all testing.

D. Each test report shall include:
1. Summary of project
2. Description of equipment tested
3. Description of test
4. Test data
5. Analysis and recommendations

E. Test data records shall include:
1. Identification of Testing Organization
2. Equipment Identification
3. Ambient conditions
4. Dates of inspections and tests
5. Identification of the testing technician
6. Indication of inspections, tests and calibrations to be performed and recorded
7. Indication of expected results of calibrations
8. Indication of as-found and as-left results, as applicable

F. Submit completed report no later than 30 days after completion of each test.

G. Provide five (5) copies of final test reports assembled in binders for record.

1.8 TRAINING

A. Refer to specification section 017900-Demonstration and Training.

B. Contractor shall provide training in compliance with specification section 017900.

C. System training for systems not being commissioned by a third party commissioning agent shall also follow the guidelines of the Demonstration and Training specifications.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Furnish test equipment as required to perform all testing required by these specifications and as recommended by the equipment manufacturer. Test equipment shall be properly calibrated and accurate. The Testing Organization shall have a calibration program in accordance with NETA ATS-2009 and shall maintain the appropriate records.

B. Furnish temporary connections, lugs, cabling and incidental materials as may be required for the start-up, testing and commissioning.

C. Infra-red cameras shall provide real-time viewing of the area being scanned, as well as a photographic record of the thermal image. Camera shall be FLIR P-Series, or equal approved.

2.2 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. At the completion of the Work and before the final payment is made, the Contractor shall furnish three (3) complete Maintenance and Operating Instruction Manuals. Each manual shall consist of a heavy duty three ring binder containing the following:

1. A title page, with the Owner's Name, Project Name, Date, Contractor Name, Engineers Name and Phone Numbers.
2. A table of contents, organized so as to permit quick and convenient reference.
3. Index tabs correlated to the table of contents.
4. Maintenance instructions.
5. Maintenance and replacement parts.
6. Operations manuals with operating instructions for all equipment supplied.
7. An instruction manual containing a brief description of system and basic operating instructions, including such items as preparation for starting, summer operation and, winter operation.
8. Manufacturer's names and model numbers of all components of the system.
9. Final shop drawings and submittals as approved by the Engineer.
10. Manufacturer's literature describing each piece of equipment and replacement parts.
11. As-built diagrams and sequence of operation by the manufacturer.
12. All load test reports.
13. All start-up reports.
14. Processed Warranty Cards for all equipment furnished.

B. The Contractor shall furnish the Manuals to the Engineer for review.

2.3 AS-BUILT DRAWINGS

A. Contractor shall submit to the Engineer a complete set of prints which have been neatly marked up from the record Drawings to represent as-built conditions for all work.

2.4 GUARANTEE

A. The work shall be guaranteed as provided in the General Conditions and Electrical General Provisions unless more stringent requirements are stated herein. The Contractor shall file with the Owner any and all guarantees from the equipment manufacturers along with the operating conditions and performance capacities they are based on.

B. Manufacturers' warranty procedures shall be followed by the Contractor. All warranty forms shall be completed by the Contractor and copies of all warranties shall be included in the Operating and Maintenance Manuals.

2.5 REPORTS

A. Start up reports shall be submitted for each piece of equipment installed by the Contractor.

B. Start-up reports shall include as a minimum the following information for each piece of equipment and system as measured or set at start-up:

1. Equipment designation corresponding to the Drawings
2. Equipment design conditions from the Drawings and Specifications
3. Measured voltage and current for each phase.
4. Nameplate voltage and phase characteristics
5. Control settings (If applicable)
6. Certification that Limit and Safety Controls function properly (If applicable)

PART 3 - EXECUTION

3.1 COOPERATION

A. All subcontractors and manufacturers involved in the commissioning process shall fully cooperate with the Contractor to fulfill the intent of this Section.

3.2 METHOD OF PROCEDURE (MOP)

A. The Contractor shall prepare a "pencil copy" MOP and schedule to be presented for review by the Engineer and Owner. The MOP shall outline the tests to be performed, safety procedures to be followed, and expectations. Contingency plans for failures should be listed.

B. The MOP shall be reviewed and changes may be made subject to the Engineers and Owner's approval. The revised MOP shall be distributed by the Contractor.

3.3 COMMISSIONING SCHEDULE

A. The Contractor shall schedule preliminary start-ups, testing, adjusting, balancing and other commissioning activities to fulfill the requirements of this section in a complete, expeditious manner.

3.4 EQUIPMENT START-UPS

A. Equipment will be subject to a preliminary start-up and a separate acceptance test.

B. Preliminary start-ups shall be conducted by the Contractor with a factory authorized technician and other subcontractors in attendance as required.

C. Tests and start-up documentation shall be completed during the preliminary start-ups to fulfill requirements for reports specified herein.

D. The Owner has the option of attending preliminary start-ups and shall be notified of all preliminary start-up dates a week in advance.

3.5 ACCEPTANCE TEST

A. The Contractor shall arrange a system acceptance test with the following individuals in attendance:
   1. Contractor's representative
   2. Subcontractor representative
   3. Electric Subcontractor representative
   4. Engineer
   5. Owner's representative

B. The Contractor shall provide all parties with a minimum of ten (10) working days notice as to the date of final start-up program and forward confirmation in writing to the Owner indicating the names, phone numbers, and association of the individuals who will be in attendance. Written confirmation to be received within five working days of the final start-up date.

C. The final start-up requirements shall not relieve the Contractor or his Sub-contractors from providing a complete working system.

D. The Contractor shall provide sufficient manpower to accomplish final start-up while all parties are on site as scheduled. The Contractor shall provide additional manpower, as required, after the final start-up program to provide a complete functioning system to the satisfaction of the Owner.

3.6 TESTING OF CIRCUITS

A. Test circuits in accordance with the requirements of the appropriate Section. Record test results and include in reports.

3.7 TESTING OF EQUIPMENT

A. Test equipment in accordance with the requirements of this Section and of the Section related to the equipment involved. Record test results to fulfill the requirements specified herein for Reports.

3.8 LOAD BANK TESTING

A. Load banks shall be provided to test under load as part of acceptance test for generators and UPS. While under load, each component shall be scanned with an infra-red camera to detect overheating of any contacts or connections.

3.9 ADJUSTMENTS

A. Adjust all time delay relays to provide proper operation.
B. Solid state circuit breakers shall be adjusted to appropriate values per circuit breaker coordination study. Adjust long-time pickup settings to match trip value per circuit breaker coordination study. Short-time pickup, delay time and other settings shall be adjusted to suit the load and upstream protection.
C. Adjust ground-fault devices as specified in circuit breaker coordination study.
D. Adjust emergency lights, motion sensors, etc., to suit room characteristics, use and mounting position of the device.

3.10 FINAL INSPECTION

A. A final inspection meeting shall be scheduled by the Contractor when all work has been completed. Owner and Engineer shall be present, along with the Contractor and other subcontractors as requested by the Owner. Any items found to be incomplete shall be submitted to the Contractor in the form of a punch list. Submission of a punch list does not relieve the contractor of any requirements of this contract.

3.11 OPERATING AND MAINTENANCE PERSONNEL TRAINING

A. The Contractor shall instruct the Owner's designated personnel as to the operation of all equipment and controls of the systems, as well as the proper operation and maintenance of the equipment.

3.12 ADJUSTMENTS AFTER COMPLETION

A. Contractor shall be responsible for adjustments required to equipment for a period of one year after acceptance by Owner.

PART 4 - TEST PROCEDURES

4.1 DRY-TYPE TRANSFORMERS (TESTING TO BE PERFORMED BY THE TESTING ORGANIZATION)

A. Inspect for physical damage, broken insulation, tightness of connections, defective wiring, and general condition. (NETA ATS 7.2.1.1.1)
B. Thoroughly clean unit prior to making any tests.
C. Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and windings-to-ground. Test voltage shall be 1000 VDC and minimum resistance shall be in 500 Megohms. Results to be temperature corrected.
D. Verify that the transformer is set at the specified tap.
E. Perform thermographic scan.
F. Verify proper core grounding.

G. Verify proper equipment grounding.
H. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

4.2 LOW VOLTAGE (600V) CABLES (TESTING TO BE PERFORMED BY THE TESTING ORGANIZATION)

A. Inspect exposed sections of cables for physical damage.
B. Check tightness of bolted connections by calibrated torque wrench in accordance with manufacturer's published data.
C. Perform thermographic survey.
D. Inspect compression-applied connectors for proper cable match and indention.
E. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts for 1 minute.
F. Minimum insulation-resistance values shall be not less than two megohms,
G. Investigate deviations between adjacent phases.

4.3 LOW VOLTAGE CIRCUIT BREAKERS: INSULATED-CASE (TESTING TO BE PERFORMED BY THE TESTING ORGANIZATION)

A. Inspect circuit breaker for proper mounting.
B. Operate circuit breaker to insure smooth operation.
C. Inspect case for cracks or other defects.
D. Check tightness of bolted connections and cable connections by calibrated torque-wrench method in accordance with manufacturer's published data.
E. Perform thermographic survey.
F. Inspect mechanism contacts and arc chutes in unsealed units
G. Perform a contact resistance test.
H. Perform an insulation-resistance test at 1000 volts differential pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
I. Perform insulation resistance test at 1000 volts do on all control wiring. Do not perform the test on wiring connected to solid state components.
J. Perform adjustments for final settings in accordance with breaker setting sheet when applicable.
K. Perform long-time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately unless series testing is required to defeat ground fault functions. Record trip time. Make external adjustments as required to meet time-current curves.
L. Determine short-time pickup and delay by primary current injection.
M. Determine ground-fault pickup and time delay by primary current injection.
N. Determine instantaneous pickup current by primary injection using run-up or pulse method.
O. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and. trip operation, trip-free, and antipump function.
P. Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to insure operation of shunt trip devices. Check the operation of electrically-operated breakers in their cubicles.
Q. Verify the calibration of all functions of the trip unit by means of secondary injection.
R. Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.
S. Insulation resistance shall not be less than 100 megohms.
T. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
U. All trip times shall fall within allowable limits as per NEMA Standard AB4, latest edition. Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.
V. Instantaneous pickup values shall be within values shown in NEMA Standard AB4, latest edition.
W. For draw-out breakers, check cell fit and element alignment. Check racking mechanism.

4.4 GROUNDING ELECTRODE SYSTEM (TESTING TO BE PERFORMED BY THE TESTING ORGANIZATION)

A. Visual and Mechanical Inspection (NETA ATS 7.13.1)
   1. Perform all standard visual and mechanical inspections
   2. Bolted electrical connections shall be verified by use of a torque wrench

B. Electrical Tests (NETA ATS 7.13.2)
   1. Perform fall-of-potential on grounding electrode system.

4.5 THERMOGRAPHIC SURVEY (TESTING TO BE PERFORMED BY THE TESTING ORGANIZATION)

A. Perform a thermographic survey in accordance with NETA-ATS on the following equipment:
   1. Switchboards
   2. Distribution Panels
   3. Panelboards
   4. Dry type transformers
   5. Enclosed circuit breakers, 100 ampere and larger
   6. Disconnect switches, 100 ampere and larger
   7. UPS & maintenance bypass
   8. Automatic transfer switches

B. The initial survey shall be conducted after the building is completed, all building systems are operating normally and all owner furnished data processing equipment has been installed and is operational.

C. A second follow up survey shall be conducted within 12 months after the initial survey. This survey shall be conducted during a period of maximum loading during the cooling season.

4.6 TESTING TO BE PERFORMED BY THE CONTRACTOR

A. Emergency Lighting Tests
   1. Open lighting panel main circuit breaker to verify proper operation of all emergency lighting battery units. Adjust position of lighting heads as required and replace defective equipment. Operate battery systems for emergency lighting without power for 90 minutes.

B. Voltage Adjustment:
   1. Measure the plant voltage with the plant operated at both no load and at nominal load at the following locations:
      a. Main Distribution Switchboard
      b. Each panelboard bus
      c. Adjust all transformer taps to bring the no-load voltage to nominal voltage
      d. After all adjustments have been made, re-measure all voltages.

4.7 TESTING TO BE PERFORMED WITH A MANUFACTURER'S REPRESENTATIVE

A. The following equipment shall inspected, adjusted, energized and operated by a service technician who is trained and authorized by the equipment manufacturer. Upon completion of startup, provide the manufacturer's written certification that the equipment has been installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service technician. Equipment acceptance testing shall be scheduled with the Owner's representative. The Owner and Engineer reserve the right to witness all testing.

B. Emergency Generator and Automatic Transfer Switches
   1. On site acceptance testing shall be performed in accordance with NFPA 110, Standard for Emergency and Standby Power Systems.
   2. Prior to startup, the Contractor shall complete all visual and mechanical inspections recommended by NETA ATS-2009 7.22.1 and 7.22.3.
   3. Tests shall be performed at 100 % generator kW rating. The Contractor shall provide all necessary load banks to conduct acceptance tests.
   4. All protective devices and control functions shall be set and adjusted.

C. Uninterruptible Power Supply
   1. Prior to start up the Contractor shall complete visual and mechanical inspections recommended by NETA ATS-2009 7.22.2, Items 1 through 5. Complete Item 7 by use of torque wrench.
   2. Refer to Specification 263353, Static Uninterruptible Power Supplies for additional requirements.

END OF SECTION 26 08 00

SECTION 26 09 13 - EMERGENCY POWER OFF CONTROLLER (EPOC)

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install a control panel to interface automatic shut down of the HVAC and Electrical Systems in the server room (data center) from the EPO and Clean agent fire suppression system.

1.2 MANUFACTURER

A. The EPOC shall be a TripMaster XL (Vendor P/N "TM-XL), as manufactured by Darwell Integrated Technologies, Inc (D.i.T, Inc), or equal

1.3 RELATED SECTIONS

A. Related Sections include the following:
   1. Section 263353-Static Uninterrupted Power Supply

1.4 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
   1. Product Data: Provide information for each type of product specified.

C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work to describe the work.
   1. Manufacturer to propose spacing and layout of supporting devices including heights, spacing, and frequency.

D. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

E. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.5 OPERATION

A. The EPOC shall be mounted in a secure, indoor location. The EPOC once installed and wired will operate as follows:
   1. When a remote EPO switch is pressed or an Emergency Power Off signal from the fire suppression system is received the EPOC will capture the EPO request and latch the emergency

shutdown request. An indicating LED will light showing the EPO shutdown circuit is active and latched.

2. All EPO output relays will make, thereby shutting down all connected power and facility equipment loads.
3. The EPO output relays will remain closed until the EPO Reset switch is depressed on the face of the EPOC.
4. Once reset the EPO output relays will return to the normal condition until another remote EPO switch is pressed.

PART 2 - PRODUCT

2.1 CONTROLLER

A. The EPOC will include 20 Form "C" non-powered relay contacts for emergency power off control of facility equipment. A maintenance manual override should be provided for each EPO output to prevent operation of the output.

B. There shall be up to four terminals for remote EPO switch inputs. A remote EPO reset shall be provided. 12 volts DC power shall be provided to operate lamps in remote EPO switches.

C. An EPO Inhibit key lock switch will be provided to disable EPO output relays while maintenance is being performed on the EPO system. An LED will indicate the EPOC is in the Inhibit condition.

D. The EPOC shall be provided with battery backup for operation during power outage. They will be charged by the EPOC's power supply.

E. The EPOC shall be provided with a built-in EPO Time Delay, (TD). The TD will time out when the remote EPO switch is activated. The TD shall be user adjustable for 1 – 10 seconds. No EPO output relays will make and lock until after the programmed time delay has completed. The TD is used to prevent accidental power outages due to EPO switch bounce.

2.2 REMOTE EPO SWITCH (REPO)

A. EPO system shall be provided with remote EPO switch shall be Tripmaster XL REPO, quantity as shown on drawings.

B. REPO specifications:
   a. Locking push button with twist-to-return reset operation.
   b. Two Form "A" normillay open contact rated 40Amps at 24Vac.

C. REPO shall be provided with protective cover to prevent incidental contact.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. All wiring and installation shall comply with national and local electrical codes and manufactures requirements. All manufacturer minimum clearances shall be observed.

3.3 TRAINING

A. Contractor shall provide Owner with training of EPO controller to demonstrate all normal functions of the controller.

END OF SECTION 26 09 13

SECTION 26 12 19.10 THREE-PHASE PAD-MOUNTED DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SCOPE

A. This specification covers the electrical and mechanical characteristics of 750kVA Three-Phase Step-Down Pad-Mounted Distribution Transformers.

1.2 APPLICABLE STANDARDS

A. All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following ANSI/IEEE, NEMA, and Department of Energy standards.

C57.12.00 – IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

C57.12.28 – Pad-Mounted Equipment - Enclosure Integrity.

C57.12.34 – IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVA and Smaller) - High Voltage: 34500GrdY/19920 Volts and Below; Low-Voltage: 480 Volt 2500 kVA and Smaller (issued in March 2005 - combines C57.12.22 and C57.12.26).

C57.12.90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.

C57.12.91 – Guide for Loading Mineral-Oil-Immersed Transformers.

NEMA TR 1-1993 (R2000) – Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels for Liquid-Immersed Power Transformers.

NEMA 260-1996 (2004) – Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas.
10 CFR Part 431 – Department of Energy – Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.
B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.
C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   1. Transformer
D. The following data shall be provided with submital:
   1. Core losses (when requested per Sections 7.4 and 10.0).
   2. Winding losses (when requested per Sections 7.4 and 10.0).
   3. Percent Impedance
E. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work to describe the work. Include:
   1. Manufacturer to propose spacing and layout of supporting devices including heights, spacing, and frequency.
   2. Complete dimensioned outline drawing, showing overall length, width and height, equipment weight, ratings of equipment and installation clearances and restrictions.
   3. Mounting details and conduit access areas.

4. Wiring diagrams.

F. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post – consumer content.
   2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

G. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES;
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

Part 2 -**PRODUCT**

2.1 **APPROVED MANUFACTURERS**

A. Cooper Power Systems—Waukesha WI
B. General Electric
C. ABB

2.2 **RATINGS**

A. The transformer shall be designed in accordance with this specification and the kVA rating shall be: As indicated on drawings.
B. The primary voltage, configuration, and the basic lightning impulse insulation level (BIL) shall be: 4,160GrdY/2,400 volts, 60kV BIL.
C. The secondary voltage, configuration, and the basic insulation level (BIL) of the secondary voltage shall be 480Y/277 Volts, 30kV BIL.
D. The transformer shall be furnished with full capacity high-voltage taps. The tap changer shall be clearly labeled to reflect that the transformer must be de-energized before operating the tap changer as required in Section 4.3 of ANSI C57.12.34. The tap changer shall be operable on the higher voltage only for transformers with dual voltage primaries. The unit shall have one of the following tap configurations:
E. Two – 2 ½% taps above and below rated voltage (split taps)
F. The average winding temperature rise above ambient temperature, when tested at the transformer rating, at the base transformer rating, shall not exceed 55°C, and when tested at 112% of the base rating, shall not exceed 65°C.
G. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 2. For target impedances, the tolerance on the impedance shall be +/- 7.5% of nominal value for impedance values greater than 2.5%. The tolerance on the impedance shall be +/- 10.0% for impedance values less than or equal to 2.5%.

Table 2
Percent Impedance Voltage

KVA Rating (Low voltage < 700 V)	Impedance
75	1.10 - 5.75
112.5-300	1.40 - 5.75
500	1.70 - 5.75
750-3750	5.75 nominal

KVA Rating	Low voltage > 700 V (all nominal values)		
	≤150 kV BIL	200 kV BIL	250 kV BIL
1000 - 5000	5.75	7.00	7.50
7500 - 10000	6.50	7.00	7.50

2.3 **CONSTRUCTION**

A. The core and coil shall be vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system. While under vacuum, the windings will be energized to heat the coils and drive out moisture, and the transformer will be filled with preheated filtered degassed insulating fluid. The core shall be manufactured from burr-free, grain-oriented silicon steel and shall be precisely stacked to eliminate gaps in the corner joints. The coil shall be insulated with B-stage, epoxy coated, diamond pattern, insulating paper, which shall be thermally cured under pressure to ensure proper bonding of conductor and paper. Coils shall be copper.

B. The dielectric coolant shall be listed less-flammable fluid meeting the requirements of National Electrical Code Section 450-23 and the requirements of the National Electrical Safety Code (IEEE C2-2002), Section 15. The dielectric coolant shall be non-toxic*, non-bio accumulating and be readily and completely biodegradable per EPA OPPTS 835.3100. The base fluid shall be 100% derived from edible seed oils and food grade performance enhancing additives. The fluid shall not require genetically altered seeds for its base oil. The fluid shall result in zero mortality when tested on trout fry *. The fluid shall be certified to comply with the US EPA Environmental Technology Verification (ETV) requirements, and tested for compatibility with transformer components. The fluid shall be Factory Mutual Approved, UL Classified Dielectric Medium (UL-EOUV) and UL Classified Transformer Fluid (UL-EOVK), Envirotemp® FR3 fluid. *(Per OECD G.L. 203)

2.4 **TANK AND CABINET ENCLOSURE**

A. The high-voltage and low-voltage compartments, separated by a metal barrier, shall be located side-by-side on one side of the transformer tank. When viewed from the front, the low-voltage compartment shall be on the right. Each compartment shall have a door that is constructed so as to provide access to the high-voltage compartment only after the door to the low-voltage compartment has been opened. There shall be one or more additional fastening devices that must be removed before the high-voltage door can be opened. Where the low-voltage compartment door is of a flat panel design, the compartment door shall have three-point latching with a handle provided for a locking device. Hinge pins and associated barrels shall be constructed of corrosion-resistant material, passivated AISI Type 304 or the equivalent.

B. A recessed, captive, penta-head or hex-head bolt that meets the dimensions per ANSI C57.12.28 shall secure all access doors.

C. The compartment depth shall be in accordance with C57.12.34, unless additional depth is specified.

D. The tank base must be designed to allow skidding or rolling in any direction. Lifting provisions shall consist of four lifting lugs welded to the tank.

E. The tank shall be constructed to withstand 7 psi without permanent deformation, and 15 psi without rupture. The tank shall include a 15 psig pressure relief valve with a flow rate of minimum 35 SCFM.

F. The exterior of the unit shall be painted ANSI 61 gray in color. If a special paint color is specified, a federal spec number or paint chip must be provided at the time of order. The cabinet interior and front plate shall be painted gray for ease of viewing the inside compartment.

G. The tank shall be complete with an anodized aluminum laser engraved nameplate. This nameplate shall meet Nameplate B per ANSI C57.12.00.

2.5 **HIGH VOLTAGE BUSHINGS AND TERMINALS**

A. High voltage bushings will be installed in the high voltage termination compartment located on the front left of the transformer and requiring access via the low voltage termination compartment on the front right.

B. Bushing Style

1. 15/25 KV DEADFRONT, CURRENTS BELOW 200 AMPS: The high voltage bushings shall be 15/25 kV 200A bushing wells with bushing well inserts installed. The bushings shall be externally

removable and be supplied with a removable stud.

C. Bushing Configuration
   1. **15/25 KV LOOP FEED DEADFRONT:** The transformer shall be provided with six (6) high voltage bushings in accordance Figure 2 dimensions (Figure 5a dimensions may be specified when a larger termination compartment for greater working space is desired) of ANSI C57.12.34 for loop feed configurations. The bushing heights shall be in accordance with Figure 3 minimum dimensions (Figure 6 dimensions may be specified for greater bushing height) of ANSI C57.12.34

2.6 LOW VOLTAGE BUSHINGS AND TERMINALS

A. Bushing Style
   1. The transformer shall be provided with tin-plated spade-type bushings for vertical takeoff. The spacing of the connection holes shall be 1.75" on center, per ANSI C57.12.34 figure 13a. The quantity of connection holes shall be 8 holes.
   2. Transformers secondary will have one piece low voltage bushings.
   3. Bushing supports shall be provided for transformers requiring 10 or more connection holes. Bushing supports shall be affixed to the cabinet sidewalls; tank-mounted supports mountings are not acceptable.

B. Bushing Configuration
   1. The transformer shall be provided with bushings in a staggered arrangement in accordance with Figure 11a dimensions (Figure 12a dimensions may be specified when a larger termination compartment for greater working space is desired) of ANSI C57.12.34.

2.7 SWITCHING

A. Primary switching scheme provided with the transformer shall be one on-off under oil load-break switch.
   1. Provide external visible load break on/off swit ch.

2.8 OVERCURRENT PROTECTION

A. Provide Bay-O-Net with back-up current limiting fuses. The high voltage over current protection scheme provided with the transformer shall be an external removable loadbreak expulsion Bay-O-Net fuse assembly with flapper valve to minimize oil spillage. The bayonet fuses shall be in series with ELSP under-oil partial-range current-limiting back-up fuses with an interrupting rating of 50,000 amps.

2.9 OVERVOLTAGE PROTECTION

A. The overvoltage protection scheme provided with the transformer shall protect the high-voltage or low voltage winding.

B. DEAD-FRONT BUSHINGS: (maximum 150 kV BIL, for voltages up to 18 kV delta and 35 kV grounded wye). Externally mounted, Distribution Class M.O.V.E. Dead-front elbow arresters shall be supplied.

2.10 LABELING

A. A temporary bar code label shall be attached to the exterior of the transformer in accordance with ANSI C57.12.34.

2.11 FINISH PERFORMANCE REQUIREMENTS

A. The tank coating shall meet all requirements in ANSI C57.12.28 including:
   1. Salt Spray
   2. Crosshatch adhesion
   3. Humidity
   4. Impact
   5. Oil resistance
   6. Ultraviolet accelerated weathering
   7. Abrasion resistance – taber abraser

B. The enclosure integrity of the tank and cabinet shall meet the requirements for tamper resistance set forth in ANSI C57.12.28 including but not limited to the pry test, pull test, and wire probe test.

2.12 **PRODUCTION TESTING**

A. All units shall be tested for the following:
1. No-Load (85°C or 20°C) losses at rated current
2. Total (85°C) losses at rated current
3. Percent Impedance (85°C) at rated current
4. Excitation current (100% voltage) test
5. Winding resistance measurement tests
6. Ratio tests using all tap settings
7. Polarity and phase relation tests
8. Induced potential tests
9. Full wave and reduced wave impulse test

B. Minimally, transformers shall conform to efficiency levels for liquid immersed distribution transformers, as specified in Table I.1 of the Department of Energy ruling. "10 CFR Part 431 Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule; October 12, 2007." Manufacturer shall comply with the intent of all regulations set forth in noted ruling. This efficiency standard does not apply to step-up transformers.

C. In addition, the manufacturer shall provide certification upon request for all design and other tests listed in C57.12.00, including verification that the design has passed short circuit criteria per ANSI C57.12.00 and C57.12.90.

D. In the event of proposal bid evaluated with guaranteed losses due to a loss evaluation (see section 10.0), manufacturer shall conform to guaranteed average losses as specified in ANSI C57.12.00. The no-load losses of a transformer shall not exceed the specified no-load losses by more than 10%, and the total losses of a transformer shall not exceed the specified total losses by more than 6%.

2.13 **ACCESSORIES**

A. The following accessories and options shall be provided:
1. Automatic pressure relief valve
2. Ground provisions per C57.12.34 section 9.11.
3. Meet NEMA TR-1 sound levels
4. Liquid level gauge
5. Dial-type thermometer gauge
6. Pressure vacuum gauge
7. Upper fill valve
8. Ground connectors
9. Mr. Ouch warning & danger signs
10. Danger high voltage warning signs
11. Non-PCB decal
12. Seismic zone 3 and 4 tank anchoring
13. FM Global (FM) Approved transformer (to comply with NEC 450-23 listing restrictions for installations on, near, or inside of buildings)
14. Combination UL Listed & Classified transformer (to comply with NEC 450-23 listing restrictions for installations on, near, or inside of buildings) per UL XPLH

Part 3 -**EXECUTION**

3.1 **EXAMINATION**

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a

manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer.

3.2 **INSTALLATION**

A. Mount transformers on equipment pad as indicated on the plans.
B. Provide all cable terminations.
C. Ground all transformers in accordance with Grounding Specifications, and applicable NEC sections.
D. Measure secondary voltage. Adjust taps to as necessary.

3.3 **SHIPPING**

A. Transformers, 1000 kVA and below, shall be palletized. Transformers, 1500 kVA and larger, shall be loaded and unloaded with overhead cranes, so a pallet is not to be provided for these transformers.

3.4 **SERVICE**

A. The manufacturer of the transformer shall have regional service centers located within 2 hours flight time of all contiguous 48 states. Service personnel shall be factory trained in commissioning and routine service of quoted transformers.

END OF SECTION

SECTION 26 22 13 – TRANSFORMERS

PART 1 - GENERAL

1.1 SCOPE

A. Provide Candidate Standard Level (CSL) 3 transformers as indicated on the drawings and specified herein.
B. Related work specified elsewhere:
C. General Provision - Section 260501
D. Grounding and Bonding - Section 260526

1.2 REFERENCES

A. FEDERAL REGISTER – US Department of Energy, Office of Energy Efficiency and Renewable Energy. 10 CFR Part 430, July 29, 2004. Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers; Proposed Rule
B. ANSI/NEMA ST 20 - Dry Type Transformers for General Applications.
C. EPACT 2005 - United States Energy Policy Act 2005 / NEMA TP1 - Guide for Determining Energy Efficiency for Distribution Transformers
D. ANSI/NEMA TP-2 – Standard Test Method for Measuring Energy Consumption of Distribution Transformers
E. ISO 9000:2000 – International Standards Organization - Quality Management System

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.
B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
C. Product Data: Provide information for each type of product specified.
D. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

E. Submitted product data shall include the following:
   1. Copy of ISO 14001:2004 Certification
   2. Insulation system impregnate data sheet as published by supplier.
   3. Construction details including enclosure dimensions, kVA rating, primary & secondary nominal voltages, voltage taps, BIL, unit weight
   4. Basic Performance characteristics including insulation class, temperature rise, core and coil materials, impedances & audible noise level, unit weight.
   5. Inrush Current (typical 3 cycle recovery).
   6. Short Circuit Current data:
      a. Primary (Sym. O/P S/C) & Secondary (L-N/G S/C)

7. Efficiency Data
    a. No load and full load losses per NEMA ST20
    b. Linear load Efficiency data @ 1/6 load
    c. Linear load efficiency data @ 1/4, 1/2, 3/4 & full load
    d. Linear Load Efficiency @ 35% loading tested per NEMA TP-2.
    e. Efficiency under K7 load profile at 15%, 25%, 50%, 75%, 100% of nameplate rating.

F. Description of manufacturer's factory nonlinear load test program
G. Factory ISO 9001 procedure describing nonlinear load test program
H. Meter and CT details including model, accuracy, serial numbers and calibration information.
I. Copy of Linear & Nonlinear load test report for a representative 75kVA transformer
J. 25 year Product Warranty Certificate

1.4 MANUFACTURER'S FACTORY NONLINEAR LOAD TEST PROGRAM

A. The nonlinear load bank shall consist of a phase-neutral loading with a k-4 profile, representative of a mix of typical commercial equipment.
B. Meters and CTs shall both be revenue class accurate. CTs shall be operated within their approved accuracy loading range. Dual meters shall gather simultaneous primary and secondary energy and harmonic data. Meter and CT details including model, accuracy, serial numbers and calibration information.
C. Efficiency: Measurements shall be taken at multiple load levels and plotted to show compliance with specification and correlation to the designed efficiency curve.
D. Efficiency shall be determined purely by measurements using method and instrumentation per NEMA TP-2 Standard. Other methods are not acceptable.
E. Harmonic data including current and Voltage THD at the different load levels shall be included with the test report.

1.5 WARRANTY

A. Transformer shall carry a 25-year pro-rated warranty, which shall be standard for the product line.

1.6 COMMERCIAL PRODUCT

A. Transformer shall be a standard item in the manufacturer's catalog.

PART 2 - PRODUCTS

2.1 TRANSFORMERS

A. Copper-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to NEMA ST20 and relevant NEMA, UL and IEEE standards; 200% rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be U.L. and CSA Listed and bear the label. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.

2.2 INSULATION SYSTEM

A. Shall be NOMEX-based with an Epoxy Co-polymer impregnant for lowest environmental impact, long term reliability and long life expectancy
B. Class: 220 degrees C
C. Impregnant Properties for low emissions during manufacturing, highest reliability and life expectancy
D. Epoxy co-polymer
    1. VOC: less than 1.65 lbs/gal (low emissions during manufacturing)
    2. Water absorption (24hrs @25C): less than 0.05% (superior insulation, longer life)
    3. Chemical Resistance: Must have documented excellent performance rating by supplier

4. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance)
5. Dissipation Factor: max. 0.02 @25C to reduce aging of insulation, extending useful life
6. Operating Temperature Rise: 130 degree C in a 40 degree C maximum ambient
7. Noise levels: Per NEMA ST-20

E. Production Test every unit.

F. UL Listed & Labeled K-Rating: K-4 or higher

G. Maximum No Load Losses shall not exceed:
1. 15kVA: 70W
2. 30kVA: 125W
3. 45kVA: 150W
4. 75kVA: 200W
5. 112.5kVA: 250W
6. 150kVA: 330W
7. 225kVA: 480W
8. 300kVA: 600W
9. 500kVA: 850W
10. 750kVA: 1400W

H. Efficiency at 1/6 loading shall meet or exceed:
1. 15kVA: 97.0%
2. 30kVA: 97.1%
3. 45kVA: 97.8%
4. 75kVA: 98.1%
5. 112.5kVA: 98.4%
6. 150kVA: 98.4%
7. 225kVA: 98.4%
8. 300kVA: 98.5%
9. 500kVA: 98.8%
10. 750kVA: 98.8%

I. Shall meet or exceed DOE 10 CFR Part 430 CSL 3 Efficiency requirement, tested per NEMA TP-2:
1. 15kVA: 97.6%
2. 30kVA: 98.1%
3. 45kVA: 98.3%
4. 75kVA: 98.6%
5. 112.5kVA: 98.8%
6. 150kVA: 98.9%,
7. 225kVA: 98.9%
8. 300kVA: 99.0%
9. 500kVA: 99.1%
10. 750kVA: 99.2%

J. Efficiency under k-4 nonlinear load at 25% of nameplate rating:
1. 15kVA: 97.6%
2. 30kVA: 97.8%
3. 45kVA: 98.1%
4. 75kVA: 98.4%
5. 112.5kVA: 98.7%
6. 150kVA: 98.7%
7. 225kVA: 98.7%
8. 300kVA: 98.8%
9. 500kVA: 99.0%
10. 750kVA: 99.0%

K. Voltage Taps: For transformers 30kVA-300kVA, provide two 2-1/2% full capacity taps above and below nominal primary voltage. For transformers 15kVA and smaller as well as 500kVA and larger provide one 5% full capacity tap above and below nominal primary voltage.
L. Impedance: Between 3.5% and 5.8% unless otherwise noted.
M. Enclosure type: Ventilated NEMA 1, indoor sprinklerproof
N. Copper Terminals for lug connections
O. Maximum Footprint for 130 degree C rise model in a NEMA 1 enclosure:
   1. 17" Wide x 17" Deep x 27" High for 15kVA.
   2. 26" Wide x 18" Deep x 30" High for 30kVA, 45kVA
   3. 33" Wide x 22" Deep x 40" High for 75kVA, 112.5kVA
   4. 38" Wide x 28" Deep x 52" High for 150kVA
   5. 38" Wide x 32" Deep x 52" High for 225kVA, 300kVA
   6. 52" Wide x 38" Deep x 61" High for 500kVA
   7. 63" Wide x 46" Deep x 67" High for 750kVA

P. Transformer Options
   1. Electrostatic Shield: Each winding is independently single shielded with a full-width copper electrostatic shield
   2. Surge Protection Device: UL 1449 listed, with EMI/RFI Filtering. Rating: 80kA/mode

Q. Provide one or more integrated infrared scanning windows as required, in order to permit the thermal scanning of all transformer primary and secondary feeder terminations without requiring opening of the transformer enclosure or exposure to live parts.
R. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable standards.
S. Transformer windings shall be copper.
T. Sound levels shall be guaranteed by the manufacturer not to exceed NEMA Standard sound levels for each KVA range.
U. Transformers shall be as manufactured by Powersmiths International Corp. ("eSaver-C3L" Series), or equal approved.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer.

3.2 INSTALLATION

A. Mount transformers on floor, to wall or suspended from the structure above as indicated on the plans.
B. Do not install transformer ventilation openings closer than 12-inches from any wall surface or other surface. Examine areas and conditions under which transformers are to be installed. Notify Architect/Engineer of conditions detrimental to proper completion of work.
C. Provide all the necessary steel supports required. For transformers suspended from above, mount by trapeze method utilizing threaded rods secured to the structure, metal channel and mounting brackets.
D. Cushion mount transformers on rubber vibration isolators. Primary and secondary connection shall be terminated with 24" long flexible metal conduits.

E. Ground all transformers in accordance with Grounding Specifications, and applicable NEC sections.
F. Adjust taps to compensate for 460V primary where applicable.

3.3 TESTING

A. Perform continuity tests for primary phase to phase connections, secondary phase to phase connections and secondary phase to ground connections. Continuity test values shall reasonably approximate manufacturer's values (generally below 20 OHMS).
B. Perform primary to ground and primary to secondary winding and secondary to ground, if applicable, insulation tests. Insulation resistance test values shall be immediately reported to Engineer.
C. Measure all primary and secondary voltages both under no load and full load conditions. Transformer taps shall be adjusted to reasonable maintain secondary voltages under full load conditions without excessive secondary voltage rise under no load conditions. No load voltage shall be approximately 105% of the nominal voltage. Improper test values shall be immediately reported to the Engineer.

END OF SECTION 26 22 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE

A. Provide panelboards in accordance with the Contract Documents. This section covers the following: 600V, 3 phase, 4 wire, 277/480V power distribution panelboards when not integral to unit substation or serving as service entrance.
B. 480V, 3 phase, 4 wire, 277/480V lighting and appliance panelboards.
C. 240V, 3 phase, 4 wire, 120/208V lighting and appliance panelboards.
D. UL labeled and rated for service voltage, supplied with protective devices as schedule on drawings, dead-front construction with mains of ampere rating specified on drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. General Provisions - Section 26 05 01
B. Panel Schedules - On Drawings
C. Grounding and Bonding – 26 05 26
D. Electrical Identification-26 05 53

1.3 REFERENCES

A. The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.
   1. NEMA PB 1 - Panelboards
   2. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
   3. NEMA AB 1 - Molded Case Circuit Breakers
   4. UL 50 - Enclosures for Electrical Equipment
   5. UL 67 - Panelboards
   6. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures
   7. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards
   8. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers
   9. Federal Specification W-P-115C - Type I Class 1
   10. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.
   11. Federal Specification W-C-865C - Fusible Switches
   12. NFPA 70 - National Electrical Code (NEC)
   13. ASTM - American Society of Testing Materials
   14. IBC – International Building Code – Seismic compliance requirements
   15. NFPA 5000 – NFPA Building Code – Seismic compliance requirements
   16. ASCE 7 – American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures – Seismic compliance requirements.

1.4 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.
B. Product Data General: Submit manufacturer’s product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
C. Product Data: Provide information for each type of product specified.

D. Shop Drawings: Submit shop drawings indicating equipment dimensions, bus bracing, list of component devices and arrangement, finish, trim types and nameplates.
E. Maintenance data.
F. Warranties: Sample warranties.
G. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS

1.5 WARRANTY

A. Manufacturer shall warrant specified equipment to be free from defects in materials and workmanship for eighteen (18) months from the date of purchase.

PART 2 - PRODUCTS

2.1 POWER DISTRIBUTION PANELBOARDS

A. I-LINE Circuit Breaker Distribution Panelboard
   1. Interior
      a. Shall be rated 600 Vac or 250 Vdc maximum. Continuous main current ratings as indicated on associated schedules and drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
      b. Provide UL Listed short circuit current ratings (SCCR) as indicated on drawings not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII.
      c. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
      d. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 100 through 600 amperes shall be plated copper. Bussing rated 800 amperes and above shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel-mounting pan by fasteners.
      e. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
      f. A solidly bonded copper equipment ground bar shall be provided.
      g. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. [UL Listed panelboards with 200% rated solid neutrals shall have plated copper neutral bus for non-linear load applications.] Gutter-mounted neutral will not be acceptable.
      h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label, and Short Circuit Current Rating shall be displayed on the interior or in a booklet format. Leveling provisions shall be provided for flush mounted applications.

   2. Group mounted circuit breakers through 1200A
      a. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

b. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
c. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
d. Line-side circuit breaker connections are to be jaw type.

3. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

2.2 LIGHTING AND APPLIANCE PANELBOARDS

A. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule.
B. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage.
C. Panelboards shall be minimum 20" wide unless noted otherwise.
D. The distribution panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall be equipped with safety barriers.
E. CABINETS AND BOXES
1. National Electrical Code gauge steel, completely galvanized or bonderized with gutter size prescribed by Code as minimum.
2. Finish or flush cabinet exterior and interior shall be manufacturers standard, over rust inhibiting primer.
3. Provide lug welded or brazed to panelboard box for connection of feeder ground wire (and ground bushing).

F. Enclosures:
1. Type 1 Boxes:
a. Boxes shall be hot-dip zinc galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel is not acceptable.
b. Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
2. Type 1 Fronts:
a. Front shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
b. Fronts shall be hinged one-piece with door. Mounting shall be as indicated on schedules on the Drawings.
c. Panelboards rated 250 amperes and below shall have mono-flat fronts with concealed door hinges and trim screws. Front shall not be removable with the door locked. Panelboards rated above 250 amperes shall have vented fronts with concealed door hinges. Doors on front shall have rounded corners; edges shall be free of burrs.
d. Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. Lock assemblies shall be keyed alike. One key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.
3. Types 3R, 5, and 12:
a. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
b. Doors shall be gasketed and equipped with a tumbler type vault lock and two additional quarter turn fasteners on enclosures 59 inches (1499 mm) or more in height. Lock

assemblies shall be keyed alike. One key shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.

c. Maximum enclosure dimensions shall not exceed 21 inches (533 mm) wide and 9.5 inches (241 mm) deep.

G. TRIM AND DOORS

1. National Electric Code gauge steel, finished as described in previous paragraphs, shall hinge away on one side exposing all wiring gutters completely and secured by screws on the other side.
2. Doors are to be flush with concealed hinges with flush catch and lock. Provide two (2) keys per panel. Keys for all panels on project to be alike. Fusible panelboards shall be furnished without doors.
3. Door shall be provided with interior metal framed directory holder.

H. INTERNAL MOUNTING AND BUSING

1. Assembly of branch circuit units and plated buses on rigid back pan arranged to permit removal of any unit without disturbing adjacent units, with copper bus.
2. Copper bus to be plated.
3. Provide main and branch connections as indicated in schedule on plans. Capacities of bus cross section based on UL standards with maximum temperature rise of 30C above a 40 ambient.
4. Provide appropriate bus work with blank plates for circuits marked "space", "future space" or words to that effect; and provide all details required to connect future circuit breakers.
5. Main buses and back pan are to be arranged so branch circuit breakers of indicated frame size may be added or changed without machining, drilling, tapping, or altering bus connection details.
6. Circuits on panelboards to be arranged for sequence phasings. Furnish separate main lugs for each conductor and secure to bus bars by stud bolts. Use two bolts for all lugs for conductors #2-0 and larger.
7. Provide copper ground bus, electrically and mechanically connected to the box (and ground lug) and equipped with separate UL approved type terminals for each branch circuit of 30 amperes and over ampacity.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Circuit breakers shall be of the indicating type providing "ON", "OFF", and "TRIPPED" positions of the operating handle. When the breaker is TRIPPED, the handle shall assume a position between the "ON" and "OFF" positions. Breakers shall be of the quick-make, quick-break type with inverse time characteristics secured through the use of bi-metallic and a magnetic tripping element. Breakers shall be Underwriters' Laboratories listed.

B. Circuit breakers shall be Bolt-On type.

C. Two and three pole breakers shall be the common trip type. Handle extensions providing common manual operation will not be acceptable.

D. Circuit breakers 225-ampere frame and below shall be thermal-magnetic trip units and inverse time-current characteristics.

E. Circuit breakers with 400 ampere or larger frame sizes shall be true RMS solid state digital trip with interchangeable trips units.

F. An adjustable trip setting dial mounted on the front of the trip unit, or interchangeable ratings plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

a. Adjustable long-time setting (set by adjusting the trip setting dial or rating plug)
b. Adjustable short-time setting and delay with selective curve shaping
c. Adjustable instantaneous setting

d. Adjustable ground fault setting and delay

G. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
H. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override.
I. Where internal ground fault protection is specified, adjustable settings shall not exceed 1200 amperes. Provide neutral ground fault sensor for four-wire loads.
J. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.
K. Provide locking tabs on all circuit breakers serving emergency lighting, fire alarm control panel and other emergency or critical equipment. Provide to the Owner 10 spare locking tabs.
L. Circuit breakers shall be fully rated for the interrupting capacity indicated for the panelboard. Where required circuit breaker frame amps is not listed at the minimum interrupting capacity, a listed circuit breaker with a higher interrupting capacity shall be used.
M. Where a circuit breaker is serving an air conditioning unit with multiple motors, breaker shall be "HACR" type.
N. Where a circuit breaker is serving lighting fixtures, the breaker shall be rated for switching duty. Where serving HID light fixtures, they shall be so rated.

2.4 PANEL DIRECTORIES

A. Provide the following information on all panel directories: Panel designations such as; Critical Power, Power Panel or Lighting Panel distribution source, and feeder size on top of directory card.
B. Sample: Lighting Panel LP/1, 208/120V ESSENTIAL, Feeder Switch=100 Amp located on existing H.S. Brd., Feeder Size - (4)- #2, (1)- #6 Grnd. in 1-1/2" cond.
C. In addition, all panel branch circuits are to be properly identified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer.

3.2 INSTALLATION

A. Panelboards shall be installed where indicated, plumb, level and true and shall be rigidly supported independently of conduits with supporting devices as required.
B. Prior to installing recessed panelboards, verify that the wall is of sufficient depth to completely cover the back box on all sides.
C. All panelboards shall be grounded in accordance with the NEC and Section 16450.
D. At all recessed panelboards, provide (1) 1-1/4" empty conduit for future branch circuits in the wall from the panelboard to the ceiling cavity above cap.
E. Installation of adjacent panelboards shall be such that top trims are level and at the same height.
F. Where two (2) section panels are required, bolt boxes together to form one unit. Trim shall be two-piece construction with doors of equal size over each section.

G. Wiring in panelboards shall be fanned into the circuit breakers in a neat workmanlike manner and neatly secured together with plastic tie wraps.

H. Cables installed in wiring gutters of panelboards shall be neatly bundled, routed, and supported. Minimum bending radii as recommended by the wire and cable manufacturer shall not be reduced.

I. Circuit numbers on the drawings are for identification only and do not indicate the position in the panelboard. Connect the circuits with the lightest loads and the receptacle circuits near the top of panel and more heavily loaded circuits near the bottom. Balance all circuits evenly between phases so feeder wires carry approximately equal current. Rebalance is necessary.

J. In addition to any spare conduits shown, provide 1 3/4" empty conduit for each 4 spare circuits or fraction thereof from all panels recessed in walls or partitions to the hung ceiling immediately adjacent, or just below. Terminate conduits in bushings in hung ceilings or flush mounted junction boxes 6" high x 12" long at the finished ceiling where hung ceilings do not exist.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES, AND PLATES

PART 1 - GENERAL

1.1 SCOPE

A. Provide all wiring devices complete with cover plates as shown on the Drawings and in accordance with the Contract Documents.
B. Provide outlet boxes of proper type and size in accordance with the National Electrical Code and as specified herein for making connections, mounting devices or lighting fixtures, and connecting miscellaneous equipment.
C. Make provisions for telephone and data outlet wiring as shown on drawings and specified herein.

1.2 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.
B. Product Data: Submit manufacturer's technical data for each component of system specified, including product specifications and installation instructions.
   1. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.

C. Shop Drawings: Included plans, elevations, sections, details, penetrations, terminations, fasteners and attachments to other work.
D. Samples: for each product provide color and texture samples requested by Architect.
   1. Initial Selection: Submit manufacturer's color sheets and small-scale samples indicating manufacturer's full range of colors and textures for selection by Architect.
   2. Verification: Submit 8-inch x 8-inch samples for each finish, color and texture selected; prepare samples using same tools and techniques intended for actual work.

E. Field quality-control test reports.
F. Product certificates and test reports.
G. Research / evaluation reports.
H. Maintenance data.
I. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post – consumer content.
   2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

J. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES;
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

K. Quality Control Submittals:
   1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer indicating compliance with applicable "Qualifications" requirements specified below.
   2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with requirements specified below.

PART 2 - PRODUCTS

2.1 BOXES

A. Provide boxes of sufficient size to accommodate the number of conductors entering the box and all devices, clamps, etc. as required by the National Electrical Code. Do not use box extensions to provide wiring space required by the NEC.
B. Boxes, where concealed, shall be of one piece sheet steel (not sectional), galvanized construction, square or rectangular, with the proper size knockouts for the conduits.
C. Boxes concealed in tile or masonry block shall be provided with approved covers with square corners and depth to suit the thickness of the wall of the tile or block. Style of ring shall match device and finish plates to be installed.
D. Sheet steel boxes shall not be used for exposed conduit work, not in exterior or interior wet location conduit work. Where conduits run exposed or in wet locations, all outlet boxes shall be cast metal with suitable gasketted covers and fittings.
E. Boxes for ceiling outlets, which receive fixtures shall have fixture studs permanently fastened to the box construction.
F. Boxes located in classified or hazardous areas shall be approved and listed for the application.

2.2 RECEPTACLES

A. Unless otherwise specified, specification grade, 3-wire NEMA and ANSI self-grounding type UL labeled 20A, 125 volts.
B. Approved Manufacturers and Catalog Numbers: Leviton, Bryant, Hubbell or equal
C. Receptacle height, 1'-6" A.F.F. unless otherwise noted. Where baseboard radiation is installed, coordinate with approved shop drawings. When 18" height cannot be maintained, obtain approval from the Architect.
D. Receptacle color shall be as specified/selected by architect.

2.3 SWITCHES

A. Specification Grade, flush mounting, UL labeled, 20A, 120-277 volts, as manufactured by Hubbell, or equal.

DEVICE	HUBBELL
20A, Single Pole, 120-277V	**1221**
20A, 3-Way, 120-277V	**1223**
20A, 4-Way, 120-277V	**1224**
20A, Pilot Light, 120V	**1221-PLC**

B. Fan timer switch: Spring would, flush wall mount, 0-6 Hour time cycle, without Hold feature, with scaled face plate, Intermatic or equal.
C. Switch mounting height, 3'-6" A.F.F., unless otherwise noted.
D. Receptacle color shall be as specified/selected by architect.

2.4 PLATES

A. Device plates in finished areas shall be satin finished stainless steel non-magnetic type 302/304.
B. Acceptable manufacturer's of device plates for standard boxes shall be Mulberry, Bryant, Hubbell, Leviton or equal.
C. At surface mounted devices in cast boxes use sheet steel type cover plates, Appleton FSK series or Raco 800 series.
D. Weatherproof device plates for standard sheet metal boxes shall be double spring loaded cast aluminum lift covers as manufactured by Crouse-Hinds #4500, or Hubbell #5205. At "FS" boxes, plates shall be Crouse-Hinds #4500FS, Hubbell #5206 or equal.
E. Where two or more devices are installed at one location, they shall be mounted under a common plate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner’s Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner’s Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. The drawings indicate approximate locations of outlets and equipment. Verify all door swings prior to roughing for switches. Review all locations with the Owner's Representative.
B. Locate boxes so that they will be readily accessible. Boxes over suspended ceiling systems are considered readily accessible if removal of the ceiling tile permits ready access to such boxes.
C. Boxes are to be installed concealed in hollow walls and in all new masonry walls except as noted otherwise. In unfinished utility room outlet boxes may be exposed.
D. Flush outlet boxes shall be set true and flush with the finished surface. Where walls have plaster finish, boxes shall be set accordingly, and shall be provided with plaster covers where required.
E. Flush boxes in concrete block walls shall be set at the intersection of two mortar joints so that only a corner need be cut from the masonry unit.
F. Boxes on opposite sides of partitions shall be staggered. Back-to-back outlets and through-the-wall outlets are not permitted.
G. Devices grouped at one location shall be ganged together. Provide barriers between different systems and between adjacent devices when the voltage between adjacent exposed live parts exceeds 300V to ground.
H. All boxes shall be securely fastened in place to ensure electrical continuity and not be supported by conduits. Where additional supports, brackets, hangers, clamps, etc. are required, furnish and securely install same.
I. Coordinate as necessary to interface installation of wiring devices with other work. For outlets mounted above furniture or cabinetry, coordinate location and mounting heights with built-in units. Adjust outlet mounting height to agree with required location for equipment served.
J. Install wiring devices only in electrical boxes that are clean and free from excess building materials, dirt, and debris.
K. Properly align and plumb all devices and plates. Plates shall sit flat against wall and tight against device surface without strain on plate.

L. Devices, installed outdoors or in wet or damp areas subject to weather, spray, etc.; adjacent to toilet room sinks; or where indicated on the drawings shall be a ground fault receptacle or shall be protected by a ground fault interrupting circuit breaker.

END OF SECTION 26 27 26

SECTION 26 28 16 - DISCONNECT AND ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Disconnects are to be furnished and installed by the Electrical Contractor unless otherwise noted.

1.2 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
   1. Product Data: Provide information for each type of product specified.

C. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

D. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. General: Where required by Code and/or noted on drawings, provide heavy duty safety switch (fused or unfused as required and/or indicated) or Motor Circuit Protector, to disconnect all circuit wiring to motors or appliances.

B. Provide enclosed disconnect switches that meet the requirements of NEMA KS l and UL 98.

C. Fusible type enclosed switch shall be Heavy Duty type. Provide with each switch:
   1. Positive pressure fuse clips.
   2. Fuses as specified.

D. Non-fusible type enclosed switches shall be Heavy Duty type.

E. Enclosed switches shall be 600 volt rated for the horsepower and amperage as indicated on the Contract Drawings.

F. Provide enclosed disconnect switches with the number of poles and of the type indicated on the Contract Drawings.

G. Provide with ground kit. Ground kit may be field installed.

H. Enclosure:
1. Provide enclosures consisting of a box and cover conforming to the requirements of NEMA 250 and of the type indicated or scheduled on the Contract Drawings.
2. Indoor: NEMA 1 enclosures unless noted otherwise.
3. Outdoor: NEMA 3R rain-tight.
4. In wet, washdown or damp areas: NEMA 4.
5. In hazardous areas: Match area classification.
6. If not otherwise specified, provide enclosures conforming to the requirements of NEMA 250, type 1 for dry locations and NEMA 4X for outdoor or wet locations.
7. Unless otherwise indicated on the Contract Drawings, NEMA 4X enclosures shall be stainless steel.
8. External operating handle pad locking provisions in the off position interlocked with the switch mechanism to prevent normal opening of the cover unless the switch is off with interlock bypass or defeat mechanism for inspection and maintenance by qualified personnel.

I. Material:
1. Construct enclosures of code gauge sheet steel per the requirements of UL 98.

J. Finish:
1. Apply a rust-inhibiting phosphate coating to the enclosure’s sheet steel, and then finish the enclosure in gray baked enamel.
2. Provide a permanent label with the manufacturer's switch type, catalog number, and horsepower rating on the enclosure.

K. Switch Mechanism:
1. Provide a visible blade quick-make, quick-break operating handle and switch mechanism integral to the box or body, not the cover.
2. Provide dead front construction with line terminal shields and arc suppressors. Provide defeatable interlocks to prevent an unauthorized opening of the switch enclosure when the switch is in the ON position.
3. Provide the means to positively padlock the switch in the OFF position.
4. Provide a switch designed so that the switch blades are visible in the OFF position when door is open.
5. Provide UL-listed switch lugs for front removable copper cables and terminals rated for 75 degree C wiring.

L. Fuses:
1. Provide fuses rated for the voltage and amperage as indicated on the Contract Drawings.
2. For non-motor loads, provide UL Class RK1 single element, fast-acting type fuses.
3. For motor, welder, and transformer loads, provide UL Class RK5 dual element, time-delay type fuses.
4. Acceptable Manufacturers:
5. Cooper Bussman
6. UL Class RK1: Limitron®.
7. UL Class RK5: Fusetron®.
8. Gould-Shawmut.
9. Or Approved Equal.

M. Provide one set of spare fuses for each point of use.

2.2 MANUFACTURES

A. Subject to compliance with Specification requirements:
1. Eaton/Cutler Hammer

2. General Electric
3. Square D
4. Siemens
5. Or approved equal

2.3 ENCLOSED MOLDED-CASE CIRCUIT-BREAKERS:

A. Provide quick make-quick break, unit type molded-case circuit breakers.
B. Provide circuit breakers with the voltage rating, interrupting ratings, poles and trip setting as indicated on the Contract Drawings.
C. Provide factory-installed accessories as indicated and specified.
D. All terminals shall be suitable for copper conductors and shall be rated 75 degrees C.
E. Trip Units
   1. Circuit breakers less than 400 ampere trip shall be provided with thermal magnetic trip units.
   2. Circuit breakers with 400 ampere trips and greater shall be provided with true RMS electronic digital trip units with the following adjustments:
   3. Long time pick up
   4. Long time delay
   5. Short time pick up
   6. Short time delay
   7. Instantaneous pick up

F. Circuit breakers over 800 amp trip for use in 480/277 volt systems shall be provided with ground fault protection. Where indicated on the Contract Documents, circuit breakers with lower trip ratings shall be provided with ground fault protection.

2.4 ENCLOSURES:

A. Provide enclosures conforming to the requirements of NEMA 250.
B. Indoor: NEMA 1 enclosures unless noted otherwise.
C. Outdoor: NEMA 3R rain-tight.
D. In wet, washdown or damp areas: NEMA 4.
E. In hazardous areas: Match area classification.
F. Provide enclosures sized to contain the circuit breaker and all other required items.
G. Provide an interlock that prevents opening the enclosure door when the circuit breaker is in the “ON” position.
H. Provide an interlock defeater, which requires a common hand-tool to operate.
I. Provide a copper ground-bus or ground-stud.
J. Provide each enclosure with an external operator that positively indicates the “ON”, “OFF”, and “TRIPPED” positions of the enclosed circuit breaker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner’s Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner’s Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions

are acceptable to Installer.

3.2 INSTALLATION

A. Install in approximate location indicated on the drawings. Support as required with steel channel or other suitable supports.
B. Provide appropriate fuses for all fused switches and provide one spare set for each type provided.
C. Coordinate with and assist the Mechanical Contractor(s) in checking rotation, running ampere values, overload heaters and general operation and performance.

END SECTION 26 28 16

SECTION 26 29 13 - MOTORS AND MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Where noted on the drawings motors, enclosed combination starters, enclosed starters for HVAC equipment, are to be furnished by the Mechanical Subcontractor under Division 23 and Division 22 of these Specifications, except for panel mounted starters and motor control centers, as indicated on the electrical plans, as specified in;

B. Motors are to be installed by the Mechanical Subcontractor and wired by Electrical Contractor.

C. Disconnect Switches and Enclosed Circuit Breakers where shown on the drawings shall be furnished and installed by the electrical contractor.

D. Related Sections include the following:
   1. Section 26 28 16 Disconnects and Enclosed Circuit Breakers

1.2 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
   1. Product Data: Provide information for each type of product specified.

C. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

D. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES;
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.3 MOTOR INSTALLATION AND WIRING

A. Install flexible liquid-tight conduit at all motor connections. All motor circuits shall be equipped with separate green ground wire - See Section 260526.

B. Do not terminate or fasten rigid conduit or EMT to motor frames, or bases. Do not use connecting conduits to support starters and/or control enclosures.

C. Wire motors and starters specified under Division 23, in accordance with coordinating wiring diagrams. Do not use freehand field wiring diagrams or sketches.

D. Electrical subcontractors shall be responsible for the installation of the proper size thermal overload, fuse, and/or circuit breaker protection of motors (3 overloads to be provided for 3 phase equipment).

E. Upon completion of connections to any motor, and when all mechanical features permit, operate said

motor and determine that its direction of rotation and method of operation are correct. Take ammeter readings on all motor leads to determine starting current and steady state full load operating current, record these readings and determine the following:

1. Proper value of heaters (overload protection) for thermal overload protection.
2. Proper value of time delay fuses to provide safe motor operation without unnecessary blowing on starting currents but sized as close as possible to the steady state running current.
3. Setting of adjustable instantaneous trips on circuit breakers to the minimum current value which will permit motor starting without nuisance tripping.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Motors, enclosed combination starters, enclosed starters for HVAC equipment, are to be furnished by the Mechanical Subcontractor under Division 23 and Division 22 of these Specifications, except for panel mounted starters and motor control centers, as indicated on the electrical plans.

B. Manual Motor Starters: Provide starters in NEMA Standard 250 Type 1 enclosure, unless indicated otherwise on the Drawings, and having the correct number of poles needed and sufficient horsepower, or fractional horsepower rating to operate the connected motors.

C. Fractional Horsepower Manual Starters: Starter consisting of a manually operated quick-make, quick-break toggle switch equipped with melting alloy type thermal overload relay. Thermal unit sized or motor nameplate amperes and of one-piece construction and interchangeable. Starter shall be rendered inoperative when thermal unit is removed. Starter contacts of double break silver alloy type in a trip-free switch mechanism.

D. Acceptable Manufacturers:

1. Square D Company
2. Eaton Electric
3. General Electric
4. Siemens
5. Or Approved Equal

E. Combination Magnetic Motor Starter (Full Voltage): Provide starter units as indicated on the Drawings and meeting the following requirements:

F. Combination motor starters shall consist of a controller disconnecting means, magnetic motor starter, control power transformer, control relays and control pilot devices installed in a single enclosure.

G. Magnetically held, electrically operated, three pole assemblies with arc extinguishing characteristics and double break silver-alloy renewable contacts meeting NEMA ICS 2. Starters to accommodate three overload relay thermal units properly sized and installed on each phase of the respective motor to be controlled. Thermal unit must be in position to operate starter.

H. Provide a minimum of one normally open and one normally closed auxiliary contacts.

I. Three pole melting-alloy-element block-type overload relays, trip-free hand reset. Furnish thermal units.

J. Circuit breakers of the magnetic trip type meeting NEMA AB 1. Provide adjustment screw to simultaneously set the magnetic trip level of each individual pole with a single magnetic adjustment, with adjustment continuous throughout the trip range. Provide clear indication of whether the breakers are in the ON, OFF or TRIPPED position by the position of the external operating handle. Mechanically interlock handle with the unit door to prevent access unless the breaker is in the OFF position. Provide padlocking facilities to positively lock the breaker in the OFF position with from one to three padlocks with the door open or closed.

K. UL Listed short circuit rating not less than 35,000 amperes or as indicated on the Contract Documents.

L. Pilot Devices- Unless otherwise shown on the Contract Drawings provide an H-O-A selector switch and red and green pilot lights on the enclosure cover. Pilot lights shall be LED type.

M. Terminal Boards: Provide each starter with an individual terminal board within the unit, completely accessible from the front, and so arranged that connection to starter can be made from the front with the starter in place. Clearly mark terminals and indicate on the manufacturer's supplied interconnection

diagrams.

N. Voltage:
   1. Control Voltage: 120 volts, using individual control transformers. Control transformers having a capacity of 100VA minimum and be provided with primary and secondary fuses.

O. Enclosure: NEMA Standard 250 Type 12, unless indicated otherwise on the Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust-inhibiting phosphate and finished in gray baked enamel.

P. NEMA 4X enclosures shall be stainless steel unless otherwise noted on the Contract Drawings.

Q. Acceptable Manufacturers:
   1. Square D Company
   2. Eaton Electric
   3. General Electric
   4. Siemens
   5. Or Approved Equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. Install in approximate location indicated on the drawings. Support as required with steel channel or other suitable supports.

B. Provide appropriate fuses for all fused switches and provide one spare set for each type provided.

C. Coordinate with and assist the Mechanical Contractor(s) in checking rotation, running ampere values, overload heaters and general operation and performance.

END OF SECTION 26 29 13

SECTION 26 32 13 – NATURAL GAS ENGINE ALTERNATOR SET

PART 1 - GENERAL

1.1 DESCRIPTION OF SYSTEM & SITE

A. Provide a fully enclosed weather proof and sound attenuated 400 kW/500kVA packaged engine-generator standby power system to supply electrical power at 480/277 Volts, 60 Hertz, 3 Phase, 4-wire. The generator shall consist of a liquid cooled spark-ignited engine, a synchronous AC alternator, and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter. The engine-generator stand-by power shall be provided with a single generator set, paralleled generator set shall not be permitted.

1.2 REFERENCES

A. National Fire Protection Association (NFPA)
   1. NFPA 70 National Electrical Code
   2. NFPA 110 Standard for Emergency and Standby Power Systems

B. National Electric Manufacturer's Association (NEMA)
   1. NEMA MG-1 Motors and Generators

C. Underwriters Laboratory (UL)
   1. UL 2200 Stationary Engine Generator Assemblies

D. Institute of Electrical and Electronic Engineers
   1. IEEE 446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.
B. The generator set must conform to applicable NFPA requirements.
C. The generator set shall be listed under Underwriters Laboratories listing (UL2200) for a stationary engine generator assembly.
D. Spark-ignited generators are required to meet EPA emission guidelines. Generator shall be pre-certified from the manufacturer.
E. The generator set must be pre-certified to meet EPA federal emission requirements for stationary standby.

1.4 RELATED SECTIONS

A. Section 260530- Conduit, Boxes, Wireway and Fittings
B. Section 260519- Wire, Cable and connectors.
C. Section 260800- Start-up and Commissioning
D. Section 262116- Panelboards

1.5 MANUFACTURER QUALIFICATIONS

A. This system shall be supplied by an original equipment manufacturer (OEM) who has been regularly engaged in the production of engine-alternator sets, and associated controls for a minimum of 25 years, thereby identifying one source of supply and responsibility. Acceptable suppliers are Kohler Power Systems, Cummins Onan, and

Caterpillar Inc.

B. The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.

C. Manufacturer's authorized service representative shall meet the following criteria:
   1. Certified, factory trained, industrial generator technicians
   2. Service support 24/7
   3. Service location within 75 miles
   4. Response time of 4 hours
   5. Service & repair parts in-stock at performance level of 95%
   6. Offer optional remote monitoring and diagnostic capabilities

1.6 DESIGN CRITERIA

A. Emergency generator sets rated continuous standby (defined as continuous for the duration of any power outage) at the following capacities:
   1. Generator rating specified at 0.8 power factor for standby applications.
   2. Generator Characteristics:
      a. Power Ratings (kVA/kW) as indicated on the Contract Drawings
      b. All units shall conform to:
         1 Voltage (Grounded Wye) 480Y/277
         2 Phase 3
         3 No. Of Service Wires 4
         4 Solid Ground
         5 105 degree C rise alternator

B. Load Starting Requirements: The generator shall be capable of starting the loads as indicated in the Single Line Diagram, AND Panel Schedules included in the Contact Drawings as well as 10% of additional. Maximum voltage drop on application of this load, considering both alternator performance and engine speed changes shall not exceed 15%.

C. The engine generator sets shall conform to the requirements of NFPA 110 for Level 1 systems and shall start and accept load in 10 seconds.

D. The generator set shall be UL 2200 listed.

E. The generator set shall be certified to meet the seismic requirements of the International Building Code (IBC). Refer to Contract Drawings for project seismic design criteria.

1.7 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.

C. Product Data: Provide information for each type of product specified.

D. Shop Drawings:
   1. Submit six (6) sets of bound submittals including, but not limited to, the following:
      a. Standard manufacturer's printed specification sheet showing critical engine and generator set specifications including dimensions, weights, guaranteed fuel consumption at 25%, 50%, 75% and 100% of full rated load, engine BHP available, jacket water heat rejection, cooling pump characteristics, exhaust flow rate and temperature at 25%, 50%, 75% and 100% of rated load, ventilation requirements, combustion air requirements, cooling system static head pressure limitation, exhaust backpressure limitation, rolling ampere rate for electric starting, liquid refill capacities, generator efficiency at 50%, 75% and 100% load, generator set ventilation requirements, TIF, harmonic wave distortion, transient reactance (x'd), type of winding

insulation, generator temperature rise, regulation characteristics, generator type of construction and over speed capabilities.

b. Engine and generator material composition and construction.

E. Manufacturer's printed warranty statement of the engine and generator set showing single source responsibility by the genset supplier.

a. Drawing and wiring schematics for right hand, left hand, end and top views of proposed assembly; battery rack, control cubicle, radiator, pump, heat exchanger, isolators, muffler, and flexible fittings.

b. Accessory catalog cuts including the vibration isolators, flexible exhaust coupling, muffler, batteries battery charger, mainline circuit breaker and enclosure, engine manufacturer's shutdown contactors, fuel lines, jacket water heater, and pump. Include a detailed statement concerning non-engine-generator set manufacturer's warranty policies, dealers responsibility, and duration of policy.

c. Submit manufacturer's pump specifications, installation and start-up instructions, and pump characteristic performance curves with selection points clearly indicated. Submit shop drawings, wiring diagrams and maintenance data including spare parts listed for each pump.

d. Normal operating ranges for system's temperature, pressure, and speed.

e. Manufacturer's engine and generator operation guide, parts book, service manual, warranty policy and installation guide.

f. Controls specification sheet(s)

g. Installation / Layout dimensional drawing

h. Wiring schematic

i. Sound data: sound level in dBA at 23 ft based on the configuration specified.

j. Emission certification

F. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:

1. Recycled content – documentation showing product supports pre and post - consumer content.
2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
4. Comply with recycling program and waste management procedures.

G. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:

1. Requirements of 017700 CLOSEOUT PROCEDURES.
2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

H. NFPA 110 required AHJ documentation:

1. Proto type test report; Certification of torsional compatibility; NFPA compliance statement; and Certification of rated load testing Applications with emergency system loads (NEC 700) require breaker coordination. To facilitate coordination, the following information needs to be incorporated into the submittal.

a. Alternator thermal damage and decrement curves.

b. Generator protective device time-current curves.

PART 2 - PRODUCT

2.1 ENGINE RATING AND PERFORMANCE

A. Basis of design:

1. The prime mover shall be a liquid cooled, spark-ignited, 4-cycle engine. It will have adequate horsepower to achieve rated kW output.
2. The engine shall support a 100% load step.
3. The generator system shall support generator start-up and load transfer within 10 seconds.
4. The generator shall accept a load step of 100% of rated kW with a maximum frequency dip of 12 Hz.

B. Obtain packaged generator set and auxiliary components through one source from a single manufacturer. Generator set shall be standard offering from manufacturer.

C. Acceptable manufacturers:
1. Kohler Power Systems
2. Caterpillar Power Systems
3. Cummins Power Systems
4. Or equal approved.

2.2 ENGINE OIL SYSTEM

A. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter(s) with internal bypass and replaceable element(s).

B. The engine oil pan will contain a 120vac thermostatically controlled crankcase oil heater.

2.3 ENGINE COOLING SYSTEM

A. The engine shall be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system. The coolant system shall include a coolant fill box which will provide visual means to determine if the system has adequate coolant level. The radiator shall be designed for operation in 122 degrees F, (50 degrees C) ambient temperature. For very cold environments, modify block heater requirements to support additional block heating requirements.

B. The engine shall have (a) unit mounted, thermostatically controlled water jacket heater(s) to aid in quick starting. The wattage shall be as recommended by the manufacturer. The wattage shall be upsized to support very cold environments. Block heater wattage to be submitted. For engines, 400 kW and larger, the block heater shall utilize a circulating pump.

C. Engine coolant and oil drain extensions, equipped with pipe plugs and shut-off valves, must be provided to the outside of the mounting base for cleaner and more convenient engine servicing.

D. A radiator fan guard must be installed for personnel safety that meets UL and OSHA safety requirements.

2.4 ENGINE STARTING SYSTEM

A. Starting shall be by a solenoid shift, DC starting system.

B. The engine's cranking batteries shall be lead acid. The batteries shall be sized per the manufacturer's recommendations. The batteries supplied shall meet NFPA 110 cranking requirements of 90 seconds of total crank time. Battery specifications (type, amp-hour rating, cold cranking amps) to be provided in the submittal.

C. The genset shall have an engine driven, battery charging alternator with integrated voltage regulation.

D. Thermostatically controlled battery blanket heaters are to be provided to maximize the batteries cold cranking capabilities.

2.5 ENGINE FUEL SYSTEM

A. The engine shall be configured to operate on pipe line grade natural gas.

B. The engine shall be configured to operate in a dual fuel configuration. Natural gas is to be the primary fuel. If natural gas pressure is lost, the unit shall automatically switch-over to LP vapor fuel.
C. The engine shall utilize a fuel system inclusive of carburetor, gas regulator, low gas pressure switch, and fuel shut-off solenoid. Generators larger than 80 kW are to include air-fuel-ratio control.
D. The engines internal fuel connections shall be terminated to the generator frame via an NPT fitting for easy installation.

2.6 ENGINE CONTROLS

A. Engine speed shall be controlled with an integrated isochronous governor function with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25%.
B. To support EPA emission requirements, gensets larger than 80 kW will incorporate an active air-fuel-ratio controller. The air-fuel-ratio controller shall be integrated into the generator controller to ensure security of settings and to support monitoring and remote diagnostics. External air-fuel-ratio controllers are not acceptable.
C. Engine sensors used for monitoring and control are to be conditioned to a 4-20ma signal level to enhance noise immunity.
D. All engine sensor connections shall be sealed to prevent corrosion and improve reliability.

2.7 HEATERS:

A. An engine mounted, thermostatically controlled immersion type engine water jacket heater to be provided to insure maintaining engine block coolant temperature in the range of 120 to 140 degrees F (49 to 60 degrees C).
    1. Heater to be suitable for operation on 208 volts AC power.
    2. Heater shall include a lube oil pressure switch for automatic cut-out on engine start.
    3. Provide isolation ball valves on water jacket heaters.
B. Generator winding anti-condensation strip heater, 120 volts A.C. thermostatically controlled. Factory wired to the generator panelboard. Wattage as per manufacturer's recommendations.
C. Generator control panel heater, 120 volts A.C. thermostatically controlled. Factory wired to the generator panelboard. Wattage as per manufacturer's recommendations.
D. Battery heater, 120 volts A.C. thermostatically controlled. Factory wired to the generator panelboard. Wattage as per manufacturer's recommendations.

2.8 ENGINE EXHAUST AND INTAKE

A. The engine exhaust emissions shall meet the EPA emission requirements for standby power generation.
B. For generators larger than 80 kW, the engine will incorporate a 3-way catalytic convertor to meet EPA emission requirements.
C. The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system. A rain cap will terminate the exhaust pipe after the silencer. All components must be properly sized to assure operation without excessive back pressure when installed.
D. The manufacturer shall supply a critical grade exhaust silencer as standard. For applications with site specific sound requirements (reference section 1.1), the silencer shall be selected to achieve site sound levels.
E. All exhaust piping from the turbo-charger discharge to the silencer shall be thermally wrapped to minimize heat dissipation inside the enclosure.
F. The engine intake air is to be filtered with engine mounted, replaceable, dry element filters.

2.9 ALTERNATOR

A. The alternator shall be the voltage and phase configuration as specified in this section, and on the drawings.
B. The alternator shall be a 4-pole, revolving field, stationary armature, synchronous machine. The excitation system shall utilize a brushless exciter with a three phase full wave rectifier assembly protected against abnormal transient conditions by a surge protector. Photo-sensitive components will not be permitted in the rotating exciter.

C. The alternator shall include a permanent magnet generator (PMG) for excitation support. The system shall supply a minimum short circuit support current of 300% of the rating (250% for 50Hz operation) for 10 seconds.
D. Three phase alternators shall be 12 lead, broad range capable of supporting voltage reconnection. All leads must be extended into a NEMA 1 connection box for easy termination. A fully rated, isolated neutral connection must be included by the generator set manufacturer.
E. The alternator shall use a single, sealed bearing design. The rotor shall be connected to the engine flywheel using flexible drive disks. The stator shall be direct connected to the engine to ensure permanent alignment.
F. The alternator shall meet temperature rise standards of UL2200 (120 degrees C). The insulation system material shall be class "H" capable of withstanding 150 degrees C temperature rise.
G. The alternator shall be protected against overloads and short circuit conditions by advanced control panel protective functions. The control panel is to provide a time current algorithm that protects the alternator against short circuits. To ensure precision protection and repeatable trip characteristics, these functions must be implemented electronically in the generator control panel -- thermal magnetic breaker implementation are not acceptable.
H. An alternator strip heater shall be installed to prevent moisture condensation from forming on the alternator windings. A tropical coating shall also be applied to the alternator windings to provide additional protection against the entrance of moisture.

2.10 CIRCUIT BREAKERS:

A. Generator mounted main line molded case circuit breakers as shown on the Contract Drawings shall be provided for each unit. Circuit breakers shall be sized as shown on the Contract Drawings.
B. Circuit breakers shall be 100 percent rated, solid state trip type with true RMS electronic trip unit and the following adjustable trip unit functions:
    1. Long time pickup and delay
    2. Short time pickup and delay
    3. Instantaneous pickup
    4. Ground fault pre-alarm (No trip)
C. All circuit breakers shall be provided with auxiliary contacts to indicate the position of the circuit breaker. The auxiliary contact shall be factory wired to provide a “Generator Circuit Breaker Opened” alarm at the control panel and at the remote annunciator.

2.11 CONTROLS

A. The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of NFPA 110 level 1.
B. The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation, air-fuel-ratio control (as required) and all related generator operations. The generator controller must also provide seamless digital integration with the engine’s electronic engine control module (ECM) if so equipped. Generator controller’s that utilize separate voltage regulators and speed governors or do not provide seamless integration with the engine management system are considered less desirable.
C. The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
D. Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.
E. Gensets must be maintained to remain reliable. Predictive maintenance algorithms help ensures that this maintenance work gets performed.
A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.
F. Diagnostic capabilities are critical to minimize mean time to repair (MTTR). Time stamped alarms and event

logs are essential to perform diagnostic recreation of cascading events. Strip chart (data logging & graphing) capability is essential in evaluating genset performance.

G. Diagnostic capabilities shall include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .2 msec data logging capabilities.

H. System level protection is critical to any power system. Instantaneous and steady state protective trip points are essential to creating system level protection. Without this functionality, under-voltage protection may need to be set low to accommodate a motor start and then provide no protection to a steady state "brown-out" under-voltage condition.
In addition to standard NFPA 110 alarms, the application loads should also be protected through instantaneous and steady state protective settings on system voltage, frequency, and power levels.

I. The control panel will display all user pertinent unit parameters including: engine and alternator operating conditions; oil pressure and optional oil temperature; coolant temperature and level alarm; fuel level (where applicable); engine speed; DC battery voltage; run time hours; generator voltages, amps, frequency, kilowatts, and power factor; alarm status and current alarm(s) condition per NFPA 110 level 1.

J. Generator Set Alarm and Status Display: The generator set shall be provided with alarm and status indicating lamps to indicate generator status, and existing alarm and shutdown conditions. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall include but not be limited to the following alarm and shutdown conditions on the display panel:
    1. Low oil pressure (Pre-alarm warning)
    2. Low oil pressure (Shutdown and alarm)
    3. Low coolant temperature (Pre-alarm warning)
    4. High coolant temperature (Pre-alarm warning)
    5. High coolant temperature (Shutdown and alarm)
    6. Low coolant level (Pre-alarm warning)
    7. Low coolant level (Shutdown and alarm)
    8. High Battery Voltage (Pre-alarm warning)
    9. Low Battery Voltage (Pre-alarm warning)
    10. Emergency Stop Activated (Shutdown and alarm)
    11. Overcrank (Shutdown and alarm)
    12. Overspeed (Shutdown and alarm)
    13. Ground fault (Pre-alarm warning)
    14. Not-in-Auto (Pre-alarm warning)
    15. Generator Circuit Breaker Opened (Pre-alarm warning)
    16. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

K. Furnish and install LED type remote alarm annunciator with horn, located as shown on the Drawings. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for gas pressure, high battery voltage, low battery voltage, and generator circuit breaker opened. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110.

2.12 COMMUNICATION

A. Communications shall be supported with building automation via the Modbus protocol without network cards.

B. Internet and intranet connectivity shall be provided.

C. Communication shall be provided for serial, CAN, and Ethernet bus networks.

D. The control system shall provide pre-wired customer use I/O: 4 relay outputs (user definable functions),

communications support via RS232, RS485, or an optional modem. Additional I/O must be an available option.

E. Provide remote I/O device with (8) customer programmable discrete outputs for interfacing generator with BMS system. I/O device shall be initially programmed at start-up to provide alarm indication for the following alarms;
   1. Engine Run
   2. Loss of gas pressure
   3. Engine Failure
   4. 5 Spares

F. Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality inside the generator controller shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.

2.13 ENGINE / ALTERNATOR PACKAGING

A. The engine/alternator shall be mounted with internal vibration isolation onto a welded steel base. These units shall not need external vibration isolation for normal pad mounted applications.

B. A mainline, thermal magnetic electronic LSI circuit breaker carrying the UL mark shall be factory installed. The breaker shall rated between 125% of the rated ampacity of the genset. The breaker shall be rated as shown on drawings The line side connections are to be made at the factory. Output lugs shall be provided for load side connections. The breaker is to include auxiliary contacts and shunt trip functionality.

C. The generator shall include a unit mounted 120 volt convenience outlet.

2.14 ENCLOSURE

A. The genset shall be packaged with a Level 2 sound attenuating weather protect enclosure.

B. The enclosure shall be completely lined with sound deadening material. This material must be of a self extinguishing design.

C. The enclosure shall be made of aluminum with a minimum thickness of 14 gauge. The enclosure is to have hinged, removable doors to allow access to the engine, alternator and control panel. The hinges shall allow for door fit adjustment. Hinges and all exposed fasteners will be stainless steel or JS5000. The use of pop-rivets weakens the paint system and not allowed on external painted surfaces. Each door will have lockable hardware with identical keys.

D. The enclosure shall be coated with electrostatic applied powder paint, baked and finished to manufacturer's specifications. The color will be manufacturer’s standard white.

E. The enclosure shall utilize an upward discharging radiator hood. Due to concerns relative to radiator damage, circulating exhaust, and prevailing winds.

F. Gensets with silencers mounted inside the main generator compartment shall be thermally wrapped to minimize heat stress on the surrounding components.

G. The enclosure shall include a thermostatically controlled space heater designed to maintain the enclosure at 40 degrees F.

H. A bolt-in-place removable wall panel shall be provided for maintenance and/or equipment installation.

I. The enclosure shall be provided with a 2” (51mm) high environmental protection barrier placed around the electrical stub-up area and enclosure interior wall to help prevent liquid spill-over to the environment, a wall mounted aluminum document holder, radiator cap access, and oil, fume and water drains to outside of enclosure.

J. The enclosure shall be provided with a 208/120 volt, single phase panelboard mounted in the enclosure with the following factory wired:
   1. Connections for battery charger, engine water jacket heater, generator anti-condensation strip heater, generator control panel heater and battery heater, GFCI convenience receptacle and service light(s).

K. All electrical wiring shall be run in EMT conduit. Final connections to vibrating equipment shall be made with liquid tight flexible metallic conduit.

L. Base: The engine-generator set shall be mounted on a heavy, duty steel base to maintain alignment between

components. The base shall include a battery tray with hold-down clamps within the rails.

M. Battery Charger:
1. UL listed 10 amp voltage regulated battery charger shall be provided for each engine-generator set. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
2. Loss of AC power - red light
3. Low battery voltage - red light
4. High battery voltage - red light
5. Power ON - green light (no relay contact)
6. Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses

2.15 BATTERY CHARGING ALTERNATOR

A. Provide an engine driven battery charging alternator, minimum 35 amperes.

2.16 EXHAUST SYSTEM COMPONENTS:

A. Provide following as part of generator set:
1. Gas-proof seamless ASA steel turbo ell with petcock for bleeding off any condensation that might accumulate within the exhaust piping companion flange.

B. Critical Silencer.
1. Silencer and tailpipe shall be painted with a high temperature black enamel, corrosion resistant coating.
2. All necessary high temperature insulation required for the silencer, and exhaust piping shall be furnished and installed under this Section of the Contract.

C. The enclosure shall be provided with an exhaust silencer, which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Include muffler brackets and straps; rain cap, collar and shield; flex pipe for muffler; and insulation for flex, muffler and exhaust pipe.

2.17 LOOSE ITEMS

A. Supplier to itemize loose parts that require site mounting and installation to be performed by the Electrical Contractor. Preference will be shown for gensets that factory mount items like mufflers, battery chargers, etc.
B. Flexible fuel hose for use in gas piping installation.

2.18 SPARE PARTS:

A. Fuses: One spare set
B. Filters One spare set (air, fuel, oil)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer.

Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 FACTORY TESTING

A. Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:
Verify voltage & frequency stability.
B. Verify transient voltage & frequency dip response.
C. Load test the generator for 30 minutes.
F. Load testing to be performed at rated power factor.

3.3 OWNER'S MANUALS

A. Three (3) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

3.4 COORDINATION

A. The Vendor shall direct the installing Contractor prior to and during installation, and field check the installation to assure the equipment has been properly installed.
B. The installing Contractor shall coordinate the laying and pouring of the generator concrete pad with the approved manufacturers' shop drawings prior to the pouring at the equipment pad, to assure proper sizing.
C. The installing Contractor shall coordinate the location of the electrical conduits locations with the approved manufacturers' shop drawings prior to installation to assure the conduits are properly located.
D. The Vendor shall furnish all equipment specified herein, in conformance with the terms and conditions stated and/or implied. The Vendor shall coordinate and verify the interface between each component provided to assure they are compatible and will operate properly in conjunction with each other. Note: Contractor shall maintain accurate field mark-up Drawings, these mark-up drawings will be delivered to the Engineer at the end of the project for the creation of As-Builts.

3.5 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be delivered to the site on just in time basis and shall be set in place upon delivering.
B. The Contractor shall coordinate equipment delivery and installation with Vendor.

3.6 INSTALLATION

A. Contractor shall install the complete electrical generating system including all external fuel connections in accordance with requirements of NEC, NFPA, and the manufacturer's recommendations as reviewed by the Engineer.
B. Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.
C. Examine the contract drawings and specifications in order to insure the completeness of the work required under this Section.
D. Verify measurements and dimensions at the job site; coordinate work with other trades and related specification sections. Schedule the work of this Section with the work of related trades so as not to delay job process.
E. Provide required templates and drawings as required to related trade for location of items covered under related specification sections.
F. Install generator set as indicated, in accordance with manufacturer's written instructions, requirements of the applicable electrical code and in compliance with recognized industry practices to ensure that products fulfill requirements.
G. Provide power and control wiring as required.
H. Set and level Generator enclosure on equipment pad. Electrical Contractor shall fasten the generator to the pad

as per manufacturers' instructions for compliance with seismic requirements.

I. Electrical work shall be in accordance with applicable codes and shall be rated for hazardous area as required.

3.7 TESTING

A. On site acceptance testing shall be performed in accordance with NFPA 110, Standard for Emergency and Standby Power Systems.

B. Prior to startup, the Contractor shall complete all visual and mechanical inspections recommended by NETA ATS-2009 7.22.1 and 7.22.3.

C. All protective devices and control functions shall be set and adjusted.

D. A factory authorized representative shall be present during the start-up and testing.

E. Generator Performance testing: The following tests shall be conducted onsite and two (2) copies of the test reports shall be furnished to the Owner. All tests and inspections to assure satisfactory operations of the units shall be witness by authorized representatives of the Owner. The contractor shall provide all necessary equipment and instruments to accomplish the tests. Tests shall be conducted as follows:

1. Start set and bring up to rated no load speed in the time recommended by the engine manufacturer and record the time.
2. Allow set to run for approximately 15 to 20 minutes and check and record voltage regulator range. Take and record reading of AC colts, frequency, speed and all engine instruments.
3. Load Test: It is desirable to run the load tests at 0.8 lagging power factor. The vendor may have only resistive type loads and tests with unity power factor will be acceptable.
4. The set shall be operated at rated load, with lowest lagging power factor attainable approaching 0.8, for a period of 4 hours. The following data shall be recorded at 30 minute intervals, starting at no load cold machine and ending with no load hot machine: Ambient temperature; voltage, all three phases; line current, all three phases; engine speed (RPM); engine jacket water temperature; engine lube oil temperature; engine lube oil pressure; alternator starter temperature; and frequency (Hertz).
5. The set shall operate satisfactorily during the load tests without undue vibration, overheating or distress and the output voltage and frequency shall remain within the limits specified. The voltage range and frequency range shall be recorded during the 4 hour run.
6. Regulation: The set shall be operated and the load suddenly increased in ¼ of full load steps, with lowest lagging power factor attainable approaching 0.8, to 100% rated load, and run at full load for a period of four hours. At the end of the 4 hours the load shall be suddenly reduced in ¼ load steps to no load. The following data shall be recorded at every ¼ load step and in 15 minute intervals during the four hour run at rated load: alternator load (KW), voltage and current of each phase, engine speed and frequency.
7. Test overspeed shutdown. Record engine shutdown speed (RPM) for at least three (3) tests, one with cold engine. (Overspeed shall be set for 110% synchronous speed).
    a. Test high water temperature shutdown and record shutdown temperature.
    b. Test low oil pressure shutdown and record shutdown pressure.
    c. Test over voltage shutdown and record shutdown voltage.
    d. Test low water level shutdown and record shutdown level.

3.8 SERVICE

A. Supplier of the genset and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of EGSA certified and factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

3.9 WARRANTY

A. The standby electric generating system components, complete genset and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of five (5) years. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for parts,

labor and travel. Warranty shall provide provisions for the supply of a portable generator by the manufacturer in the event repairs cannot be completed in 48 hours.

B. The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

3.10 STARTUP AND CHECKOUT

A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:

1. Ensuring the engine starts (both hot and cold) within the specified time.
2. Verification of engine parameters within specification.
3. Verify no load frequency and voltage, adjusting if required.
4. Test all automatic shutdowns of the engine-generator.
5. Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load.
6. Applications with NEC 700 emergency loads are generally required to comply with the installation and acceptance requirements of NFPA 110, section 7.13.
7. Perform a load test for 1.5 hours using building load. In addition to the building load test, load the generator at 30% for 30 minutes, 50 % for 30 minutes, and 100% for 60 minutes.

3.11 TRAINING

A. Training shall NOT be supplied by the start up technician at the time of start-up. A separate training session shall be scheduled with NJTA. Training Plan must be provided in advance, and issued to NJTA for review and approval prior to scheduling the training.

B. Refer to specification section 017900, Demonstration and Training

END OF SECTION 26 32 13

SECTION 26 33 53 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL UPS

1.1 SUMMARY UPS

A. This specification describes the operation and functionality of a continuous duty, three-phase, solid-state, static Uninterruptible Power Supply (UPS) hereafter referred to as the UPS. All UPS systems shall be capable of being deployed in an N+1 redundant, scalable architecture. This UPS can be initially deployed as a single stand-alone (SA) UPS or installed with other like systems in a standard 19" four post IT enclosure for parallel capacity (PC) power applications from 12 to 60 kW, or installed with other like systems in a standard 19" four post IT enclosure for parallel redundant (PR) power applications from 12 to 60 kW (N+1). Any system deployment shall comprise of hot swappable / user replaceable 12 kVA/12 kW electronics modules. Each replaceable12 kVA/12 kW electronics module contains individual UPS system logic controls, a power factor corrected input power converter/rectifier, PWM inverter, continuous duty bypass static switch module and battery charging circuit. Each 12 kW system shall also comprise of hot swappable / user replaceable battery modules, individual user replaceable LCD interface display, intelligent automated maintenance bypass contactor, battery breaker, individual system input breaker, and output distribution breaker. Each 12 kW module shall contain two battery strings in parallel enhancing system reliability. The system shall be designed that all modules in parallel will all equally support the individual output distribution breakers and receptacle used to connect to independent output distribution modules (Rack Power Module).

B. The UPS shall consist of the following pieces, as required by the project;

C. UPS module(s) with internal battery and internal automated maintenance bypass

D. Extended battery runtime modules

E. Paralleling power bus system located in a typical IT enclosure

F. Rack mountable power distribution modules

G. Wall mounted maintenance bypass cabinet

H. Other features as described in this specification.

1. UPS modules, extended battery modules, rack mounted power distribution modules and power distribution units, shall be capable of installation in any EIA-310-D, or EIA-310-E four post 19" IT enclosure, with minimum depth of 30 inches.
2. The paralleling power bus shall be ordered pre-installed in one EIA-310-D four post 19 inch, 24 inch wide, 42U high equipment enclosure with a depth of 1070mm or 42 inches. The 6U electrical connection wireway can be specified to be installed in the bottom or top of the IT enclosure.

I. In addition, this specification describes the following:

1. Automated UPS maintenance bypass system and its operation with the rack mounted power distribution unit, hereafter referred to as the RPM or Rack Power Module.
2. Parallel bus bar kit for installation in a standard EIA-310-D (E) enclosure.
3. Rack level power management and distribution products.
4. Software and connectivity solutions for integrating power system information into building or facility monitoring requirements.

J. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power and distribution for mission critical, electronic equipment loads.

K. All programming and miscellaneous components for a fully operational system as described in this specification shall be provided as part of the System.

1.2 RELATED SECTIONS

A. Section 26 08 00 “Start-up & Commissioning
B. Section 019100 - Commissioning

1.3 STANDARDS

A. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States.
B. CSA C22.2 No 107.1(Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.
C. IEC 62040-1-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1: General and safety requirements for UPS used in operator access areas.
D. IEC 62040-1-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-2: General and safety requirements for UPS used in restricted access locations.
E. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
F. CISPR 22: FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices.
G. Where applicable, the UPS shall also be designed in accordance with publications from the following organizations and committees
    1. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.
    2. NFPA 70E®: Standard for Electrical Safety in the Workplace®
    3. NEMA - National Electrical Manufacturers Association
    4. OSHA - Occupational Safety and Health Administration
    5. MIL-HDBK-217E (Military Handbook) – Reliability prediction of electronics equipment
    6. IEEE 519-1992 Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.
    7. ISO 9001
    8. ISO 14001

1.4 UPS MODES OF OPERATION

A. Standard: Power strategy set for High Efficiency: Utilizing commercial AC power, the critical load shall be continuously supplied regulated and protected AC power. The system shall power the load while regulating both voltage and frequency in compliance with the UPS output specifications. The system shall derive power from the commercial AC source if the input source is within the specifications for the UPS input. Upon loss of AC power or an event where the input AC source is not is tolerance the UPS shall supply DC power to the Inverter which will supply an output voltage in compliance with the output voltage specifications. System efficiency will be 97% or greater, over the range of 40% to 100% load. System efficiency will be 95% or better from 20 to 40% load. The UPS shall be able to distinguish between upstream (utility) faults and downstream (load) faults, and react appropriately to protect and support the critical load, without interruption. When High Efficiency is utilized, the UPS must attenuate ANSI C62.41-type line transients to within IEC and ITIC limits. During standard operation the AC source shall provide power for the loads in conjunction with charging the battery.
B. Normal: Power strategy set for Normal: Utilizing commercial AC power, the critical load shall be continuously supplied regulated and protected AC power. The system shall power the load while regulating both voltage and frequency in compliance with the UPS output specifications. The system shall operate in double conversion mode of operation unless forced or commanded to battery mode, bypass mode, high efficiency more or system off. The system shall derive power from the commercial AC source and shall supply DC power to the Inverter in conjunction with charging the battery. All systems shall be capable of changing between normal and high efficiency modes from the front panel of the UPS system. There shall be no time restraints for normal mode operation.

C. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied AC power by the system, which shall obtain power from the batteries without any operator intervention. Continuous operation of the critical load shall never be jeopardized during the failure or restoration of the commercial AC source.

D. Charger: Upon restoration of the commercial AC or back-up generation source, the charger shall recharge the batteries and simultaneously supply power to the input power converter (rectifier) which provides power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load.

E. Static Bypass: Each UPS power module shall incorporate a continuous duty static bypass to provide transfer of critical load from the inverter output to the bypass source. This transfer, along with its retransfer, shall have no effect on the operation of the critical load. In the event of an emergency, this transfer shall be an automatic function.

F. Maintenance Bypass: Each UPS module shall be equipped with an intelligent automated internal make-before-break maintenance bypass to isolate the UPS during routine maintenance and service of the UPS electronics or battery modules. The maintenance bypass shall be powered by a separate power supply, not part of the removable electronics module.

1.5 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.

B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.

1. Product Data: Provide information for each type of product specified.

C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work to describe the work.

1. Submittal shall include:
    a. Bill of materials.
    b. Installation information, including weights and dimensions.
    c. Drawings and details for requested optional accessories.
    d. Installation and user manual including:
        1) Instructions for storage, handling, examination, preparation, installation, and start-up of UPS.
        2) Instructions for operating the system

    e. Equipment drawings
    f. Interconnection Drawings
    g. Terminal locations for power and control connections.
    h. Battery Wiring Diagram
    i. System single-line operation diagram.
    j. UPS One-Line Drawings
    k. Equipment Outline Drawings
    l. Accessory Wiring Diagrams

D. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:

1. Recycled content – documentation showing product supports pre and post – consumer content.
2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.

4. Comply with recycling program and waste management procedures.

E. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES;
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

PART 2 - PRODUCT

2.1 DESIGN REQUIREMENTS

A. UPS basis of Design Powerware Blade UPS as manufactured by Eaton Corporation
B. The UPS shall be sized for 24 kW /24 kVA load
C. The UPS system shall/ have N+1 redundancy.
D. The UPS battery shall be sized for minimum of 18 minutes runtime at a Power Factor of .9 for a 24 kW load.

2.2 SYSTEM CHARACTERISTICS

A. System Capacity: The system shall be rated for full kW output in the following configurations:
   1. 24kW/kVA (N+1) – using four (3) 12kW UPS systems

B. When power strategy is set for Normal, all 208V systems will automatically adjust mode to power strategy - High Efficiency, if the load on the system exceeds 10kW per 12 kW system module, or 83% of capacity, for support of the load up to 12 kW per module. Power strategy will then automatically return to Normal, once load is reduced below 10kW or 83% of capacity. All N+1 configurations will include fully isolated and redundant logic controls, electronics modules, battery systems, static switch assemblies, and automatic maintenance bypass.
   1. Input Specifications:
      a. AC Input Nominal Voltage: 208Y/120V, 3 Phase, 4 wire plus ground 60 Hz.
      b. AC Input Voltage Window (range before re-transfer from battery):
      c. System loading less than 83% or 10kW per 12 kW module: 157vac to 246vac, line to line, (-24/+18%), without using stored energy mode.
      d. System loading greater than 83% or 10 kW per module: 192 to 220vac, line to line, (-8/+6%) without using stored energy mode.
      e. Transfer to battery window is typically 3 – 5% wider that re-transfer to compensate for hysteresis.
      f. Maximum Frequency Range: (automatically set upon start-up)
      g. 60 Hz operation: 55-65 Hz before switching to battery operation
      h. 50 Hz operation: 45 to 55 Hz before switching to battery operation
      i. Input Power Factor:
      j. While operating in High Efficiency: > .97 with active PFC IT loads
      k. While operating in Normal: > .99 operating from IGBT based input power converter
      l. Input Current Distortion (with no additional passive filter)
      m. While operating in HE: < 10% typical with active power factor corrected (PFC) IT loads
      n. While operating in Normal: < 5% operating from input power converter, with PFC and Non-PFC loads.
      o. Current inrush: No transformer magnetizing inrush in standard UPS
      p. From start or retransfer from battery: Shall not exceed connected load inrush

q. For parallel systems: Upon retransfer from battery each UPS module shall delay transfer to the incoming source for a minimum of 500ms (1/2 second) from the retransfer of the preceding UPS module on the same parallel bus.

2. Output Specifications:
   a. AC Output: 208Y/120V, 3 Phase, 4 wire plus ground, 60 Hz.
   b. AC Output Voltage Distortion: Max. 3% @ 100% Linear Load.
   c. AC Output Voltage Window: Selectable
      1) Conformance to ITIC curve, 187 vac to 229 vac L to L
      2) Typical per ITE Power supply regulation window: 180 vac to 229 vac L to L

   d. Voltage Transient Response:
      1) HE operation: Dependent upon input mains source, however typically maintains voltage within output specification window +/- 1% maximum for 0-100% or 100% to 0 load step
      2) Normal operation: +/- 6% RMS maximum for 0-100% or 100% to 0 load step
      3) Reserve energy mode: +/- 6% RMS maximum for 0-100% or 100% to 0 load step

   e. Voltage Transient Recovery within <50 milliseconds
   f. Static transfer duration
      1) With mode set to high efficiency: typical 2-3 ms
      2) With mode set to normal: 0 ms

   g. Output Voltage Harmonic Distortion: Stored energy or inverter operation
      1) <3% THD maximum and 1% single harmonic for a 100% linear load
      2) <5% THD maximum for non-linear load described in IEC 62040-3

   h. Phase Angle Displacement:
      1) 120 degrees $^{+}/_{-}$ 1 degree for balanced load
      2) 120 degrees $^{+}/_{-}$ 1 degrees for 50% imbalanced load
      3) 120 degrees $^{+}/_{-}$ 3 degrees for 100% imbalanced load

   i. Overload Rating
      1) Normal Operation
         a) 125% for one minute
         b) 110% for ten minutes
         c) 105% continuous

      2) Bypass Operation
         a) 125% continuous
         b) 1000% for 500 milliseconds

   j. System AC-AC Efficiency: Power Strategy set to High Efficiency >97.5% at 100% load, with nominal input voltage and frequency.
   k. System AC-AC Efficiency: Power Strategy set to Normal >91.5% at 83% load, with nominal input voltage and frequency.
   l. Output Power Factor Rating: 0.9 lead to 0.7 lag
      1) The UPS output shall not require derating for purely resistive or power factor corrected loads (PF of 1). The output kW and kVA ratings of the UPS shall be equal. For loads exhibiting a power factor of .9 leading to .7 lagging no derating of the UPS shall be required.

C. Environmental
   1. Storage Ambient Temperature: -40°F to 158°F (-40°C to 70°C)
   2. Operating Ambient Temperature: +32°F to 104°F (0°C to 40°C). (25°C is ideal for most battery types)
   3. Relative Humidity: 5 to 95% Non-condensing
   4. Altitude: Maximum installation with no derating of the UPS output shall be 3300 feet (1000m) above sea level.

D. Input Power Converter
   1. The input power converter for each 12kW system is housed within the removable electronics module. This electronics module shall also contain the system control logic, continuous duty static switch and continuous duty inverter. The input power converter shall constantly receive power from the mains input to the system, to provide the necessary UPS power for precise regulation of the DC link voltage to the inverter and battery charger, therefore maintaining regulated output power.
   2. Input Current Total Harmonic Distortion: The input current ITHD shall be actively controlled by the input power converter while operating from the converter in normal operational mode. The input ITHD shall be less than 5% at full system load.
   3. Magnetization Inrush Current: If provided with an optional isolation transformer or PDU/System Bypass, system inrush shall be limited to 10 times the nominal input current of the transformer.
   4. Input Current Limit:
      a. The input converter shall control and limit the input current draw from utility to 130% of the UPS output. With mains deviation of up to +18%/ -10% of the nominal input voltage the UPS shall be able to support 100% load, charge batteries at 10% of the UPS output rating, and provide voltage regulation per the output voltage specification in 2.2.C.
      b. When installed in a parallel configuration the UPS systems shall adjust charge levels to ensure batteries are properly charged, without compromising the parallel bus bar capacity rating, or upstream breaker ratings.

   5. Redundancy: When installing systems in a parallel redundant (PR) configuration, the system shall include redundant input converters, each with semiconductor fusing, and logic controlled contactors to remove a failed module from the power bus.
   6. Battery management system: The UPS shall contain a battery management system with the following features:
      a. Battery Recharge: The battery management system shall provide a three-step charging process. These periods shall be recognized as constant current, constant voltage and rest. After recharging batteries to full capacity, UPS shall isolate the charging circuit from the battery. Continual float charging of the battery shall not be allowed, therefore reducing the possibility of positive grid corrosion, and increasing expected battery life.
      b. Battery Runtime Monitoring: The battery management system shall monitor battery and provide status to end user of battery run time via front panel, serial/network communications, or both. Run time calculations to be based on load demand and analysis of battery health.
      c. Battery Health Monitoring: UPS shall continuously monitor battery health and the UPS will provide warnings visually, audibly and/or via serial/network communications when battery capability falls below 80% of original capacity. Battery testing may also be user initiated via the front panel or serial communications.
      d. Parallel connected systems shall independently monitor their battery voltage during discharge. Each system shall communicate with other systems on the parallel bus, sending information about current battery conditions (voltage). Each UPS shall be able to adjust output load based upon its own battery voltage, therefore systems with incorrectly connected, weak or failed batteries shall assume less load ensuring maximum runtime out of the connected battery. Adjusting output loading based on battery voltage shall not allow

a UPS inverter to exceed more than 100% of its rated capacity. Individual battery string voltage during discharge shall attempt to stabilize at +/- 1vdc when compared to other systems connected on the same output parallel bus.

e. The battery charging circuit shall remain active when in any normal mode of operation or while in static bypass mode.

7. Back-feed Protection: Each UPS shall provide a UL1778 approved back-feed protection scheme.

E. Output Inverter

1. The UPS output inverter shall be used to regulate the output voltage to operate in conjunction with the connected IT load equipment. The output inverter shall use IGBT driven power converters, operating at high frequency to limit the effects of step loads and reduce the operating audible noise from the system. In both double conversion operation and battery operation, the output inverters shall create an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the continued operation of the critical load.
2. Overload Capability: The output inverter shall be capable of supporting 300% overload for a short period, in attempt to clear any short-circuit on the output. The UPS inverter shall remain operational for one (1) minute if a steady-state overload condition of up to 125% is seen on the output of the system. If the overload persists past the outlined time limitation, the critical load will be automatically switched to the static bypass output of the UPS. In the event the static switch exceeds its overload capability, the UPS shall activate the automated maintenance bypass to continue to support the overload until activation of an overcurrent protection device, or the overload condition is removed from the system.
3. Inverter Output Isolation: The output inverter shall be provided with a semi conductor fuse and output mechanical contactor to provide overcurrent protection and physical isolation of the inverter from the critical bus. This feature allows a failed inverter to remove itself from the critical bus while not affecting the operation of other parallel systems supporting the loads. Battery Protection: Each UPS shall be capable of controlling battery discharge depth, with the additional feature of removing all DC power draw from the battery in case of an extended input power outage. This will ensure that the batteries will not be deeply discharged which could cause damage to the battery.
4. Redundancy: When installing systems in a parallel redundant (PR) configuration, the UPS shall be configured with redundant output inverters, each independently controlled from fully isolated logic control systems. The inverters shall be able to share output even if intra-module communication is lost between individual UPS modules. All UPS inverters shall utilize high speed semiconductor fusing, and logic controlled contactors to remove a failed inverter from the critical bus without affecting the output of the other modules on the bus.

F. Static Bypass

1. Each UPS system shall include a hot swappable static bypass switch. Static bypass operation will be based upon the system configuration, stand-alone single module (SA), parallel capacity system (PC), or parallel redundant system (PR). When deployed as a SA or PC UPS system, overloads exceeding the rating of the inverter, load fault, or internal failures shall automatically transfer the critical load to the commercial AC power. If a PR system is in overload the system will automatically determine if all available systems are capable of handling the overload, and if so the system will remain in normal operation. If the overload or load fault exceeds the capability of all connected systems each modules internal static bypass switch shall automatically transfer the critical load to the commercial AC power. If an internal failure occurs on a PR system, the system affected by the fault will automatically remove itself from the critical output bus, ensuring the critical load is protected by the remaining systems operating in normal operation, with no transfer to static bypass initiated. If a mode change to static bypass was the result of an overload or load fault, the system shall automatically return to normal operation once the condition is has cleared.

No-break transfer between operating modes shall be capable of being initiated manually from the front display of any parallel connected system. Each UPS shall constantly monitor the bypass input source voltage, and inhibit potentially unsuccessful transfers to static bypass from taking place.

2. The design of the static switch power path shall consist of Silicon Controlled Rectifiers (SCR) with a minimum continuous duty rating of 125% of the UPS output rating.
3. Automatic Transfers: An automatic transfer of load to static bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from static bypass back to normal operation shall take place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to static bypass shall also take place if for any reason the UPS cannot support the critical bus.
4. Manual Transfers: Manually initiated transfers to and from static bypass shall be initiated through the UPS display interface. All parallel connected systems shall transfer to static bypass simultaneously upon request from one system display.
5. Overloads: The static bypass shall be rated and capable of handling overloads equal to or less than 125% of the rated system output continuously. For instantaneous overloads caused by inrush current from magnetic devices, or short circuit conditions, the static bypass shall be capable of sustaining overloads of 1000% of system capacity.
6. Redundancy: The static bypass switch shall be incorporated into each UPS Module, so PR systems will include redundancy in the Static switch function.
7. Modular Design: The static switch assembly shall be incorporated in the electronics module therefore reducing mean time to repair (MTTR).

G. System Protection
1. Back-feed protection: As a requirement of UL1778, back-feed protection in the static bypass circuit shall also be incorporated in the system design. Back-feed protection shall be a function of a mechanical contactor in series with the bypass SCR(s). The back-feed contactor shall open immediately upon sensing a condition where back-feeding of the static switch by any source connected to the critical output bus of the system is occurring. Shorted SCRs in the static bypass assembly will cause the back-feed protection to activate.
2. Parallel connected system protection: Parallel connected systems shall include a redundant communication method for detecting if a single UPS module has initiated a transfer to bypass, which will cause all systems to transfer to static bypass mode. This communication method is used in event the primary communication between parallel connected modules fails.

H. Maintenance Bypass
1. Each 12kW UPS system shall include an automated internal maintenance bypass, which will allow hot-swappable replacement of logic control, input converter (rectifier), output converter (inverter), battery modules and static bypass switch. Parallel connected UPS modules shall be capable of full removal and replacement if necessary. Maintenance bypass operation will be based upon the system configuration, stand-alone single module (SA), parallel capacity system (PC), or parallel redundant system (PR). When deployed as a SA or PC UPS system, conditions requiring maintenance bypass operation shall force all connected systems to the maintenance bypass mode. This shall be an automated process, with activation coming from either a command from the front panel, or when a display panel RJ45 connector is unplugged from the electronics module. Overloads exceeding the rating of the static switch shall automatically transfer the critical load through the maintenance bypass to the commercial AC power. PR systems can be commanded to maintenance bypass through the front panel, however automated transfer to maintenance bypass by unplugging one display will be inhibited as long as it does not force other connected systems into an overload condition. If a front display is unplugged in PR configuration, the UPS module will take itself off-line allowing all other connected systems to support the critical load in normal operation. Overloads of the static bypass on PR systems will automatically transfer the critical load to the commercial AC power. If an internal failure occurs on a PR system, the system

affected by the fault will automatically remove itself from the critical output bus, ensuring the critical load is protected by the remaining systems operating in normal operation, with no transfer to static or maintenance bypass initiated. Each UPS shall constantly monitor the maintenance bypass input source voltage, and inhibit potentially unsuccessful transfers to maintenance bypass from taking place.

I. Output Power Distribution

1. Each 12kW UPS module shall provide power to an output connector on the rear of the UPS chassis. This connector shall be protected by a properly sized breaker (50A), limiting the output of each UPS module to its rating. This output connector shall be wired internally so that anytime it is attached to the parallel bus system; the connector shall be supported by all UPS modules on the parallel bus. The connector shall be capable of supporting loads connected to it even in event the electronics and battery modules are removed. This connector shall also be designed so that the internal UPS electronics module will support the loads on the output connector in event of a parallel bus failure. The output connector shall be monitored by the UPS controls per the information in section 2.8.c.d.

J. Display and Controls

1. System control and information network interconnections
   a. Any UPS installed as a parallel system shall connect to a digital monitoring network so information about system voltage, current and power measurements can be accessed from any system display. This network shall not be needed to ensure proper system synchronization or load balancing control for each module on the output power bus. This network will allow accumulated or single system information to be displayed on any system display. The network will also allow for full system operating mode changes to be controlled from any display. Each UPS shall also be capable of individual module control though its own independent display.
   b. Each UPS module installed in parallel shall include a digital monitoring network card, using industry standard control area network (CAN) architecture. This control architecture allows systems to operate in electrically noisy environments with extremely high reliability. This network allows accumulation of information between systems and mode control selection for all connected systems. The digital networking card will require a tool to install securely in each UPS module.
   c. Cabling for the UPS monitoring network shall consist of interconnecting cable (ANSI/TIA/EIA-568-A, Category 5e) segments secured at each UPS with an interlocked 8P8C modular plug (RJ45). All information network interconnections shall be made on independent control area network (CAN) cards, which are inserted in an independently controlled and powered communication slot on each UPS module. Each of these interconnection cables shall serve as the physical layer for the UPS information network. This network cable shall be included by the manufacturer with every control area network card purchased. And shall not require tools to install.
   d. A secondary independent control network shall be connected to each UPS module to allow system mode control changes in case of failure on the digital monitoring network. This network will ensure that if any UPS, in a parallel connected system, is in the bypass operating mode that all systems on the parallel output power bus must also be in that same operating mode. This redundancy is used to ensure that even in event of the primary digital network failure that no unsafe conditions exist for personnel working on the upstream electrical system.
   e. The secondary control network consists of a non-shielded twisted pair cable that shall daisy chain between paralleled UPS modules. The twisted pair cables shall come assembled with a two pin female connector, used to plug into a male connector header located on the back chassis of each UPS module. These male pins shall be recessed into the chassis to prevent damage during shipping or use. Each UPS module shall have two connection points that

shall not be located on the network communication card and shall be isolated from the card. UPS modules in the bottom-most and top-most positions shall only have one cable connection. Any UPS modules located in-between two other modules will have two connected cables, one to the module below and one to the module above the said module. This twisted pair cable shall be included by the manufacturer with every control area network card purchased, and will not require tools to install.

f. The length of all the interconnecting cable segments for each network shall be approximately 45 centimeters.

2. UPS performance with loss of control wiring interconnections
   a. With the complete loss of digital network communications all UPS modules shall have the capability to support the critical load up to their rated load, with no reduction in system operational capability.
   b. With the complete loss of the digital and analog network communications, all UPS modules shall have the capability to support the critical load up to their rated load; however capability to switch modes to static bypass will be inhibited.
   c. With the complete loss of one or both of the UPS communication networks, each UPS module shall have the capability to detect an internal failure and remove itself from the paralleled UPS bus.
   d. Control in this method eliminates the need for system wide synchronization control signals, therefore eliminating any possibility of a synchronization control failure causing the entire system to go off line or remove power from the critical load.
   e. It shall not be possible for a failure in the controls of one UPS power module to propagate a failure into other UPS power modules.

3. Front Panel Display: The UPS shall include a front panel display consisting of a graphical LCD display with backlight, four status LED's, and a four-key keypad. The LCD shall display a mimic screen of power flow through the UPS system when programmed for this function. The keypad keys shall be menu driven per the function being performed.
   a. Graphical LCD display: Includes basic language (English and local selectable languages), display of unit function and operating parameters. It shall be used to signify the operating state of the UPS, for indicating alarms, for changing operations control parameters and set points. The graphical display shall have a real time clock which will stamp events with event type and time information, reviewable in the logged data menus.
      1) Local language packages available:
      2) English, Spanish, German (Standard)
      3) Four status LED's, which indicate:
      4) Alarms, with a red LED
      5) On Battery, with a yellow LED
      6) On Bypass, with a yellow LED
      7) Power On, with a green LED

   b. Four-Key Multifunction Keypad: UPS shall have keypad to allow user to:
      1) Adjust UPS parameters
      2) View UPS metered data
      3) View all parallel UPS systems metered data
      4) View alarm and inverter logs
      5) Change UPS operational modes of the individual module
      6) Change operational modes of all parallel connected systems
      7) Turn individual UPS systems on and off
      8) Turn all parallel connected systems on or off

c. Metered Data: The following metered data, shall be available on the alphanumeric display:
   1) Input:
      a) Voltage Line to Neutral
      b) Voltage Line to Line
      c) Frequency

   2) Battery:
      a) Voltage
      b) Current
      c) Runtime

   3) Output:
      a) Voltage Line to Neutral
      b) Voltage Line to Line
      c) Current
      d) Frequency
      e) Power kW
      f) Power kVA
      g) Power factor (pf)

   4) Parallel System:
      a) kW [by unit]
      b) kW [Parallel total]

   5) Load Receptacle:
      a) Voltage Line to Line
      b) Frequency
      c) Power kW
      d) Power kVA
      e) Current

d. Event log: The display unit shall allow the user to display a time and date stamped log of the 100 most recent status and alarm events. Each event will be time stamped with Year, Month, Day, Hour, Minute, Second of occurring event.

e. The system shall be capable of displaying the following system status information:
   1) System Normal
   2) High Efficiency Power: %
   3) Battery Resting
   4) Battery Floating
   5) UPS in Parallel mode
   6) Parallel Unit Number
   7) Units on Parallel Bus
   8) Units on Load

f. The system control functions shall have the following capability
   1) Go to Normal Mode
   2) Go to Bypass Mode
   3) Turn UPS On/Off
   4) Turn system UPS On/Off
   5) Start Battery Test
   6) Start Display Test

g. The following system information shall be available from the front display
   1) UPS Type
   2) UPS Part Number
   3) UPS Serial Number
   4) UPS Firmware Revision
   5) UPS Display Firmware Revision
   6) UPS CAN Bridge Firmware Revision

h. Alarms and system information: The display unit shall allow the user to display a log of all active alarms. The following minimum set of alarm conditions shall be available:
   1) On Battery
   2) Battery Low
   3) On Bypass
   4) Bypass Unavailable
   5) Battery Breaker Open
   6) Battery Connection
   7) Overload
   8) Over-temperature
   9) Site Wiring Fault
   10) The UPS does not provide the expected backup time
   11) Power is not available at the UPS output receptacle
   12) The UPS does not start
   13) The UPS does not turn off
   14) The UPS operates normally, but some or all of the protected equipment is not on
   15) Battery test failed
   16) Battery test pending
   17) Battery test did not run
   18) Battery test aborted
   19) The UPS does not transfer to Bypass mode
   20) Check Parallel Board
   21) Abnormal output voltage at startup
   22) Selective Trip
   23) Redundancy Loss Due to Overload
   24) Configuration Error and the UPS does not start.

i. System Configuration: The following shall be configurable from the display unit:
   1) Set Date and Time
   2) Display Contrast
   3) Change Language
   4) Relay Configuration
   5) Signal Inputs
   6) Serial Port Configuration
   7) Parallel Operation Settings
   8) Modem Configuration
   9) Battery Setup
   10) Power Strategy (normal or high efficiency)
   11) Start Screen
   12) User Password
   13) Audible Alarms
   14) Unsynchronized Transfer to Bypass
   15) Transfer to Bypass When Overload
   16) Automatic Start Delay
   17) Control Commands from X−Slot 1

18) Control Commands from X−Slot2
19) X−Slot Signal Input Activation Delay
20) Site Wiring Fault Notice
21) Input Range
22) Reset Custom Event Settings
23) REPO Configuration

j. Communication Interface Board: A communication interface board shall provide the following communication ports which can be used simultaneously:
   1) Communication Card Slots:
      a) Each UPS shall provide (2) communication slots in the back of the system allowing for additional connectivity options, including SNMP/Web, AS/400 relays, Modbus, etc
      b) SNMP/Web and HS/400 relay cards shall be provided with UPS.

   2) Serial communications (via RS-232) with manufacturer-supplied power management software package RS232 Serial Port #1
   3) REPO Input, N/O and N/C connections for connection to isolated contact on room EPO switch:
      a) Each module in a PC or PR configuration shall require a separate EPO connection, ensuring failure of one EPO connection does not cause entire system shutdown.

   4) Two programmable signal inputs shall be programmable for the following system control:
      a) ABM Resting (Charger disable)
      b) Remote ON/OFF
      c) Remote Go To Normal
      d) Force UPS to Static Bypass (External Bypass Interface)
      e) External Battery Breaker Status (Disconnect notice)

   5) Summary alarm relay output

K. Battery
   1. The UPS battery shall be of modular construction made up of user replaceable, hot swappable, battery modules with approved over-current protection. Each UPS module shall contain a minimum of two parallel battery strings therefore reducing the chance of a single battery failure causing complete loss of runtime. Each 12kW UPS in a parallel capacity (PC) or parallel redundant (PR) configuration shall have independent battery systems, with independent battery breakers therefore reducing any chance of a single point of failure in the DC bus.
   2. The battery jars housed within each removable battery module shall be of the Valve Regulated Lead Acid (VRLA) type. The battery case shall be made of flame retardant material rated as UL94-V0.
   3. The UPS shall incorporate a battery management system to automatically monitor the health of the battery system. This UPS shall notify the user via the front panel and serial/network communications in the event that a failed or weak battery is found.
   4. Each 12kW UPS module shall have an independent 70A DC breaker for isolation of all internal and external battery modules to the DC bus. The UPS module shall notify the user if the DC breaker is in the off position.

2.3 PARALLELING BUS SYSTEM

A. A parallel bus bar system shall provide in a standard EIA-310-D four post 19" IT enclosure measuring 42 inches (1050mm) deep, 80 inches (2030mm) tall (42U) and 24 inches (600mm) wide. The parallel bus shall be rated for a maximum of 60kW N+1 of output power, allowing up to six (6) UPS modules to be connected to it in one enclosure. The enclosure shall include full length side panels, castors and split rear door. Cable entry into the enclosure shall be capable from top, bottom or sides without effecting front or rear door operation. The parallel bus shall include a 6U high power wiring area with multiple conduit landing areas appropriate for installation in raised or non-raised floor applications. The wireway area shall be available in either a top of cabinet, or bottom of cabinet configuration. The bus bar system is different between a top and bottom wireway configurations, so they are not user capable of conversion from top to bottom or vice versa modification. The parallel bus shall include both input and output bussing systems with fully rated power connections located in the wiring area. The parallel bus system shall include UL approved touch safe connectors, for easy installation and/or removal (hot swap) of individual UPS modules while power is still applied to the critical output bus. UPS system installation procedures shall be capable of being completed by the user or other designated personnel.

1. Input Specifications:
    a. Maximum continuous input current rating shall be 180A @ 208Vac
    b. Maximum input OCP protection per NEC 80% deratings shall be 225A
    c. Input lugs shall be compression type.

2. Output Specifications:
    a. Maximum continuous output current rating shall be 167A @ 208Vac, (60kVA)
    b. Maximum output OCP protection per NEC 80% deratings shall be 225A
    c. Output lugs shall be compression type.

2.4 POWER DISTRIBUTION SYSTEM

A. The UPS module output connector on the rear of the UPS chassis shall be designed to interface to a rack mounted power distributions system. Each rack mounted power distribution system (when installed on paralleled UPS modules), shall be protected by all systems on the AC output bus. This power distribution system shall be modular and scalable in relationship to the upstream UPS system modules.

2.5 EXTENDED RUNTIME BATTERY

A. Extended runtime for the UPS shall be provided for each module. These extended battery runtime modules (EBM) will come in a standard rack mount design, with capability to go into any EIA-310-D, or EIA-310-E four post 19" IT enclosure, with minimum depth of 30 inches. Each EBM shall be 3U (5.20 in / 132 mm) in height, 26 in (660 mm) depth, and 17.2 in (437 mm) width. Each EBM shall come with a standard four post rail mounting kit to ensure easy slide in installation into the rack or enclosure. EBMs shall be capable of mounting into the same enclose that houses the UPS modules, server equipment or RPMs, except enclosures configured with a 60kW N+1 UPS system will consume all 42U of available rack space. Each EBM will include a cord assembly that allows plug in capability to the rear of the UPS system or other like EBMs. Each EBM shall include a matching input connector that allows easy tool-less "daisy chaining" of additional EBM modules by plugging them together. The DC output of each EBM shall be protected by an over-current protection device (breaker) with capability of being reset without tools. The cord length of the EBM will be 36" to allow easy installation above or below any UPS, or when connecting to parallel UPS systems. When connecting to parallel UPS systems the EBMs will be designed to go into standard racks to the left of the UPS cabinet. This configuration will allow use of the standard cable length, however in cases where additional cable length is needed; an optional 36" jumper shall be available. Up to four (4) Extended Battery Modules shall be capable to be added to the standard UPS system for increased battery runtime greater than 30 minutes.

2.6 WALL MOUNTED SYSTEM MAINTENACE BYPASS

A. A wall mounted system maintenance bypass shall be provided to allow bypassing of the UPS system in case of maintenance needs on the UPS paralleling bus bar system or full UPS tower. This cabinet will include three breakers to allow make before break transfer of the connected load to a second source without disruption to the load.

1. General Requirements
   a. Standards:
      1) The maintenance bypass module shall be designed, tested, and manufactured in accordance with the latest applicable standards of UL 1778 4th edition; CSA C22.2, No. 107.3
      2) The cabinet shall be constructed and installed in accordance with all applicable current sections of NEMA, ANSI, IEEE, and NFPA® codes

   b. Storage, handling, and maintenance:
      1) Equipment shall be handled and stored in accordance with the manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment

   c. Qualifications
      1) The manufacturer shall have produced similar electrical equipment for a period of 10 years

   d. Manufacturers:
      1) The maintenance bypass cabinet shall be from Eaton Corporation

   e. Ratings as indicated on the cabinet:
      1) kVA rating: 60 kVA for matching to 60 kVA UPS system
      2) Nominal current: 225A
      3) Input: 208 vac Three-phase, 4 wire, plus ground
      4) Frequency: 60 Hz
      5) Fault Current: 65 kAIC at 240V

   f. Cabinet construction
      1) The cabinet shall be made from enclosure-grade steel
      2) The cabinet shall be capable of top, bottom and side cable entry and exit
      3) The cabinet shall include removable top and bottom conduit landing plates

   g. Bypass construction
      1) Bypass shall be constructed of three molded case circuit breakers (MCCB)
         a) UPS Input Breaker (225A)
         b) Maintenance Bypass Breaker (225A)
         c) UPS Output Breaker (225A)

      2) Bypass shall include a mechanical interlock device to force the user to close the maintenance bypass breaker before turning off the UPS output breaker, or close the UPS output breaker before turning off the maintenance bypass breaker

   h. UPS connectivity
      1) The electrical contractor shall install all power cabling between the UPS system and maintenance bypass cabinet.
      2) The manufacturer shall include communication cables between the UPS tower and maintenance bypass cabinet that will force an indicator lamp in the Maintenance By-

pass Cabinet to illuminate any time the UPS electronic modules are in a bypass mode of operation.

3) The Maintenance By-Pass Cabinet shall include a push button device that will force the connected UPS systems to internal bypass, therefore illuminating the UPS on bypass indicator on the maintenance bypass module
4) The Maintenance By-Pass Cabinet shall include a simple power flow diagram on the front of the panel, with corresponding power available lamps at the UPS input, UPS output and maintenance bypass output positions
5) All indicator lamps shall be long life LED type, with removable/replaceable fuses from the front of the cabinet
6) The Maintenance By-Pass Cabinet shall include a contact that will force any connected UPS systems into a bypass mode any time the maintenance bypass breaker (MBB) is closed. This contact will also hold the UPS from returning to normal operation until the MBB is opened.
7) The UPS system shall indicate and annunciate that the maintenance bypass system is engaged, therefore locking out the UPS from transferring back to normal operation
8) The Maintenance By-Pass Cabinet shall have connection for a remote EPO connection. The EPO shall require a momentary contact closure to shunt trip the maintenance bypass breaker.
9) The Maintenance By-Pass Cabinet shall include a single N/O and N/C auxiliary contact on all three power breakers. These contacts shall be rated to handle up to 5A @ 250 vac
10) All auxiliary contacts and EPO connections shall be terminated at a terminal block in the power wiring area of the module

2.7 SOFTWARE AND CONNECTIVITY

A. The UPS manufacturer shall be capable of providing three separate levels of system management for the data center. The following is a list of levels and their functionality:

1. Basic single UPS system operation, management and graceful load shutdown software to be included with every UPS shipped and/or is available from the manufacturers public web portal with the most recent release
    a. The included UPS software shall have automatic model detection of the manufacturer's current models of UPS systems as well as automatic detection for some competitive UPS models.
    b. The software shall provide sequential shutdown to further help network administrators determine what sequence to shut down servers during an extended power outage.
    c. The shutdown software shall be capable of being used completely unknown to the user at the display, for use on point of service or other public environments where not relevant to involve the user
    d. The software shall automatically detect time used on battery and calculate the cost savings of the UPS by not subjecting the user to downtime.
    e. Software Compatibility, the supplied with each UPS sold shall support graceful shutdown and remote monitoring for the following systems:
        1) Microsoft: Windows 2000 (Server, Advanced Server, Professional) Windows XP Home Windows XP Professional, Windows 2003 Server (Web, Small Business), Windows 2003 Server (Standard, Enterprise), Windows 2003 Server R2 (Standard, Enterprise), Windows Vista (Ultimate, Home Premium, Business), Windows XP on 64-bit architecture, Windows Server 2008, Windows 7, Microsoft Hyper-V, Microsoft Hyper-V Server
        2) HP-UX v. 10.20, 11.0, 11i (11.11), 11i v1.6 (11.22), 11i v2 (11.23)
        3) BM AIX: v. 4.3.2 for RISC, v. 4.3.3 for RISC and PowerPC 3, v. 5.1, 5.2, 5.3 for PowerPC 3, v. 5.3 for PowerPC 5

4) Mac OS v. 10.2.x 10.3.x, 10.4.x, 10.5x
5) Red Hat 7.2, 8.0 9.0, Red Hat Enterprise Linux 3 and 4 (ES and AS),Red Hat Enterprise Linux 4 (ES, AS, and Desktop), Red Hat Enterprise Linux AS v. 2.1 and v. 3 2, Fedora Core 5
6) SCO Unix OpenServer v. 5.0.6, 5.0.7
7) SGI Irix (MIPS) v. 6.5.2.x
8) Sun Solaris v. 7, 8, 9, 10 for SPARC, v. 7, 8, 9, 10 for Intel
9) SuSE Linux v. 7.2, 8.0, 8.2, 9.0, 9.3, 10.0, SuSE Enterprise Linux Server 8 and 9
10) Fedora Linux – Core 5, 6
11) Ubuntu Linux v. 6.10
12) Novell NetWare v. 5.0, 5.1, 6.0, 6.5 (must upgrade to latest SP)
13) VMWare ESX v. 3.5 (Linux Kernel 2.4), ESXi v. 3.5, 4.0 / vSphere Management Assistant VMA 4.0, VMware®'s vCenter™ server
14) Cisco Unified Communications Manager 4.3

f. Optional data center, Windows®-based client/server software package (Power Xpert) that provides real-time monitoring of critical power conditions for the entire enterprise down to a single channel or parameter of the UPS. It is specifically designed to support multiple UPS systems in the data center including:
   1) Real-time, enterprise-wide monitoring analyzes critical power conditions and identifies problems
   2) Drill-down monitoring of individual meter or status for the UPS isolates the issue and speeds diagnosis
   3) Monitoring via client (local or remote), server or the Web (computer or PDA) provides easy "anywhere/anytime" access
   4) Scalable architecture (single/multi server) allows network managers the flexibility to monitor power conditions from within each LAN or monitor multiple LANs from a centralized, master client
   5) Alarm notification through alphanumeric paging and/or SMTP email speeds corrective action
   6) Customizable alarms tailor notification to user needs
   7) Powerful data collection, graphing and report writing toolset provide trend analysis and diagnosis of chronic power problems.

2. UPS monitoring and management
   a. Network management: An Ethernet WEB/SNMP and ModBus TCP network communication adaptor shall be available to allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP and/or ModBus network environments. SNMP information shall be available in the standard management information base (MIB) data, which can be used by network management software programs. SNMP information shall be provided in DOS and UNIX "tar" formats. The WEB/SNMP interface adaptor shall be a hot swappable card capable of being inserted into any open UPS communication slot.
      1) Parallel connected UPS modules shall be able to be monitored from one WEB/SNMP card in any of the paralleled UPS communication slots. In this configuration all modules are monitored and managed as one UPS system. Individual UPS monitoring shall be capable by utilizing one communication card for all UPS modules paralleled on the parallel bus bar system.

   b. A single network management card shall have the capability of interfacing and delivering WEB/SNMP and ModBus TCP information concurrently
   c. Unattended shutdown shall be a function of the UPS reporting operating data to a network management device, so that IT systems can gracefully shut down. When utility AC is lost

and the UPS is operating on battery, information sent about battery runtime is used to determine if and when the IT systems should start their automatic shutdown.

d. Each UPS system shall also be capable of using an RS232 port to communicate by means of serial communications to gracefully shut down one or more operating systems during operation on battery.

e. A facilities management card with ModBus RTU shall be available as an option.

f. Isolated potential free contacts shall be available with an optional relay interface board. This relay interface board shall come if two different models, one for low voltage/low current applications and the other for voltages up to 250Vac and currents up to 5A. Either relay interface board shall change relay states for UPS changes from the following list:
   1) Normal Operation
   2) Battery Operation
   3) Bypass Operation
   4) Common Fault
   5) Low Battery
   6) UPS Off.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.3 STANDARD EQUIPMENT WARRANTY

A. Standard equipment warranty shall be five (5) years from the date of substantial completion.

3.4 FACTORY ASSISTED UPS STARTUP

A. Provide factory assisted UPS start-up, factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

1. VISUAL INSPECTION
   a. Visually inspect all equipment for signs of shipping damage and/or foreign materials
   b. Observe type of ventilation, room cleanliness, use of proper signs and any safety related items that may be noteworthy

2. MECHANICAL INSPECTION
   a. Check internal power connections in UPS module for tightness while observing proper safety precautions
   b. Check all control wiring terminations and plugs in UPS module for tightness and/or proper setting

c. Check to see that all factory connections, power modules, subassembly pans and legs are secure
d. Inspect the auxiliary connections and devices connected to UPS system

3. ELECTRICAL PRECHECK
   a. Check system for ground faults at all power inputs and outputs
   b. Check DC bus for short circuits and proper polarity
   c. Checks input and bypass power terminations for proper voltages and phase rotation inside all modules
   d. Check and adjust, if necessary, all power supply voltages
   e. Verify CTO and Serial numbers programmed into system match the equipment labels

4. INITIAL UNIT ENERGIZATION
   a. Verify all system annunciations are in "go" condition
   b. Energize unit(s) and verify proper DC walkup and AC phase on
   c. Check DC link holding voltage, AC output voltages and output waveforms
   d. Check final DC link voltage and inverter AC output. Adjust if required
   e. Check for proper synchronization with bypass source
   f. Check voltage differences between inverter outputs and bypass source
   g. Power up all additional accessories (EBM/RPM)

5. BATTERY SET-UP
   a. Determine common or separate battery set-up process and settings
   b. Check for proper cell interconnections with respect to polarity throughout battery
   c. Check battery configuration matches required unit configuration (voltage, polarity, number of cells per string)

6. BRANCH CIRCUIT MONITORING SET-UP (if optionally purchased on RPM)
   a. Ensure installation configuration matches application
   b. Perform branch circuit breaker scheduling
   c. Check voltage and current calibrations

7. OPERATIONAL INSPECTION
   a. Check proper system operation in Normal Mode, Bypass Mode, and Battery Mode
   b. Check system transitions between operating modes
   c. Check multi-module operations
   d. Verify system calibrations and adjust as necessary

8. FUNCTIONAL TEST
   a. Switch on utility power at UPS connection point
   b. Energize UPS and verify no alarms are present (or have been corrected and cleared)
   c. Test Battery mode
   d. Simulate the loss of bypass when on battery testing
   e. Emergency transfer testing
   f. Configure UPS. 5.3.1. Select appropriate display language
   g. Set Date and Time
   h. Set number of EBMs
   i. Building Alarms testing
   j. Local and Remote Emergency Power Off testing

9. INSPECTION COMPLETION
   a. Ensure dead fronts and door panels are reinstalled
   b. System will be left in normal mode when environmental controls are operational

c. Conduct on-site customer system operation training
d. Final EEPs, calibration EEPs, meters report, service log, and configuration reports will be downloaded and stored
e. Startup data forms and reports are available as required
f. Clean up tools and debris around the system
g. Register the warranty if applicable

3.5 MANUFACTURER FIELD SERVICE

A. The UPS manufacturer shall have a worldwide service organization, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support
B. Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, and 365 days a year. The worldwide service organization shall be capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be delivered to the customer site within 24 hours

3.6 MAINTENANCE CONTRACTS

A. A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available. All contract work shall be performed by Eaton authorized trained service personnel
B. Contracts shall be available for both Monday through Friday, normal business hours next day response, and seven days a week, any hour with up to two (2) hour response time

3.7 TRAINING

A. UPS service training: Provided on-site UPS service training first responder course shall be provided from the UPS manufacturer. The service training workshop shall include a combination of lecture and practical instruction with hands-on sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.
B. Training shall NOT be supplied by the start up technician at the time of start-up. A separate training session shall be scheduled with NJTA. Training Plan must be provided in advance, and issued to NJTA for review and approval prior to scheduling the training.
C. Refer to specification section 017900, Demonstration and Training

END OF SECTION 26 33 53

SECTION 26 36 23.1 - AUTOMATIC TRANSFER SWITCH AND BY-PASS ISOLATION

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install automatic transfer and by-pass isolation switch (ATS/BPS) system(s) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All automatic transfer switches and controllers shall be the products of the same manufacturer.

B. The automatic transfer switches and controls shall conform to the requirements of:
   1. UL 1008 - Standard for Transfer Switch Equipment
   2. IEC 947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
   3. NFPA 70 - National Electrical Code
   4. NFPA 99 - Essential Electrical Systems for Health Care Facilities
   5. NFPA 110 - Emergency and Standby Power Systems
   6. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
   7. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
   8. UL 508 Industrial Control Equipment
   9. related sections

C. Related Sections include the following:
   1. 260501- Electrical General Provisions
   2. 260503-Electrical Related Work
   3. 260548- Vibration and Seismic Controls for Electrical Systems
   4. 260573- Short Circuit/Coordination Study
   5. 260800- Start-up and Commissioning
   6. 263213-Natural Gas Engine Alternator Set
   7. 019100 - Commissioning

1.2 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.

B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.

C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   1. Automatic Transfer Switches
   2. Bypass Isolation Switches
   3. Accessories

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work to describe the work. Include:
   1. Manufacturer to propose spacing and layout of supporting devices including heights, spacing, and frequency.
   2. Complete dimensioned outline drawing, showing overall length, width and height, equipment weight, ratings of equipment and installation clearances and restrictions.
   3. Mounting details and conduit access areas.
   4. Wiring diagrams.

E. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post – consumer content.

2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
4. Comply with recycling program and waste management procedures.

F. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
1. Requirements of 017700 CLOSEOUT PROCEDURES;
2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

PART 2 - PRODUCTS

2.1 MECHANICALLY HELD TRANSFER SWITCH

A. Basis of design ASCO 7000 Series automatic transfer switch.
B. Automatic transfer switch shall be as manufactured by ASCO or equal by Russell Electric, Eaton.
C. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
D. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
E. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
F. All main contacts shall be silver composition. Switches shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
G. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
H. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
I. Where neutral conductors must be switched as shown on the plans, the AS shall be provided with fully rated overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100 milliseconds.

2.2 BYPASS-ISOLATION SWITCH

A. A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.
B. Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.

C. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.

D. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.

E. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

F. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

G. Designs requiring operation of key interlocks for bypass isolation or ATSs which cannot be completely withdrawn when isolated are not acceptable.

2.3 MICROPROCESSOR CONTROLLER

A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

D. All field connections shall be wired to a common terminal block to simplify field-wiring connections.

E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1.	EN 55011:1991	Emission standard - Group 1, Class A
2.	EN 50082-2:1995	Generic immunity standard, from which:
3.	EN 61000-4-2:1995	Electrostatic discharge (ESD) immunity
4.	ENV 50140:1993	Radiated Electro-Magnetic field immunity
5.	EN 61000-4-4:1995	Electrical fast transient (EFT) immunity
6.	EN 61000-4-5:1995	Surge transient immunity
7.	EN 61000-4-6:1996	Conducted Radio-Frequency field immunity
8.	IEEE472 (ANSI C37.90A)	Ring Wave Test.

2.4 ENCLOSURE

A. The ATS shall be furnished in a freestanding, floor mounted Type 1 enclosure unless otherwise shown on the plans.

B. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

2.5 CONTROLLER DISPLAY AND KEYPAD

A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controlller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration; Open transition.
5. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.6 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	**N&E,3ϕ**	**70 to 98%**	**85 to 100%**
Overvoltage	**N&E,3ϕ**	**102 to 115%**	**2% below trip**
Underfrequency	**N&E**	**85 to 98%**	**90 to 100%**
Overfrequency	**N&E**	**102 to 110%**	**2% below trip**
Voltage unbalance	**N&E**	**5 to 20%**	**1% below dropout**

B. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

D. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

E. Source status screens shall be provided for both normal & emergency to pro-vide digital readout of voltage on all 3 phases, frequency, and phase rotation.

2.7 TIME DELAYS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
   1. Prior to transfer only.
   2. Prior to and after transfer.
   3. Normal to emergency only.
   4. Emergency to normal only.
   5. Normal to emergency and emergency to normal.
   6. All transfer conditions or only when both sources are available.

F. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

G. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

2.8 FEATURES

A. A three position momentary-type test switch shall be provided for the ***test / automatic / reset*** modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

F. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

G. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

H. An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.

I. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

J. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
   1. Enable or disable the routine.
   2. Enable or disable transfer of the load during routine.
   3. Set the start time:
      a. Time of day
      b. Day of week
      c. Week of month (1st, 2nd, 3rd, 4th, alternate or every)
      d. Set the duration of the run.

K. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

L. System Status - The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,
   1. Normal Failed
   2. Load on Normal
   3. TD Normal to Emerg
   4. 2min15s

M. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.

N. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

O. Communications Interface – The controller shall be capable of interfacing, through a serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

P. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
   1. Event Logging
      a. Data and time and reason for transfer normal to emergency.
      b. Data and time and reason for transfer emergency to normal.
      c. Data and time and reason for engine start.
      d. Data and time engine stopped.
      e. Data and time emergency source available.
      f. Data and time emergency source not available.

   2. Statistical Data
      a. Total number of transfers.
      b. Total number of transfers due to source failure.
      c. Total number of days controller is energized.
      d. Total number of hours both normal and emergency sources are available.

Q. Communications Module - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to ASCO Accessory 72.

R. Provide Indicator features 18B and 18G to provide indication to BMS system that "Normal" and "Emergency" 3-phase power is available. Each feature shall provide a two-pole, double-throw contacts that operate when the monitored source voltage is present at the terminals.

S. Provide features 14a/14b to provide auxiliary contacts to be monitored by the BMS system to monitor the switch position. This feature shall provide four sets of two-pole, double-throw contacts that operate when the monitored source voltage is present at the terminals.

T. Provide load shed feature 30A for future use by client.

2.9 WITHSTAND AND CLOSING RATINGS

A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.
B. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATS which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

PART 3 - EXECUTION

3.1 TESTS AND CERTIFICATION

A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
C. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

3.2 SERVICE REPRESENTATION

A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

3.3 INSTALLATION

A. The contractor shall install equipment per manufacturer’s requirements and contract drawings.
B. All necessary hardware to secure the ATS in place shall be provided by contractor.
C. The equipment shall be installed and checked in accordance with manufacturers written instructions. This shall include but not be limited to:
   1. Check to ensure that the pad is level to within a ¼”. Level pad surface as required.
   2. Check to ensure all cables are torqued to the manufacturer’s requirement.
   3. Secure equipment to the equipment pad.

3.4 COMMISSIONING

A. Field test and verify proper operation of automatic transfer switch.
B. Field test and verify all pick-up and drop-out settings and sensing relays.

3.5 TRAINING

A. Training shall NOT be supplied by the start up technician at the time of start-up. A separate training session shall be scheduled with NJTA. Training Plan must be provided in advance, and issued to NJTA for review and approval prior to scheduling the training.
B. Refer to specification section 017900, Demonstration and Training

END OF SECTION 26 36 23.1

SECTION 26 36 23.2 - MANUAL TRANSFER SWITCH

PART 1 - GENERAL REQUIREMENTS

1.1 SCOPE:

A. Contractor shall furnish, deliver, install and test the manual transfer switches as specified herein and in accordance with the drawings.

1.2 QUALITY ASSURANCE:

A. Manual transfer switch shall be UL listed and labeled under the UL 1008 standard.
B. Manual transfer switch manufacturer shall provide a complete factory assembled, wired and tested manual transfer switch.
C. Manual transfer switch shall be factory Hi-pot tested for a period of not less than 60 seconds.
D. Manual transfer switch installation shall meet all applicable NEC standards.

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.
B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.
C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
D. Shop Drawings
   1. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
      a. Contractor shall submit manufacturer's drawings and data of manual transfer switches for Engineer's approval prior to start of fabrication. Drawings and data shall include, as a minimum, dimensioned general arrangement drawings and wiring diagrams, UL listing information including UL control or file number, component data, mounting provisions, conduit entry locations and installation instructions.
E. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
      a. Certified as-built General Arrangement drawings and Wiring Diagram.
      b. Materials / Component List including part numbers.
      c. Maintenance and service requirements.
      d. Certificate of Compliance and hi-pot test data.
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.
F. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

1.4 WARRANTY

A. Manual transfer switches shall be covered by manufacturer's warranty for a minimum period of (1) one year after shipment from manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL:

A. All equipment shall be new.
B. Manual transfer switch manufacturer must have produced and sold manual transfer switches as a standard product for a minimum of (3) years.
C. Manual transfer switches shall be molded case circuit breaker type; knife switch or fused switches are not acceptable.
D. Contractor shall be responsible for the equipment until it has been installed and is finally inspected, tested and accepted in accordance with the requirements of this Specification.
E. Manual transfer switches shall be StormSwitch as manufactured by ESL Power Systems, Inc. or equal as approved by the Engineer.

2.2 MANUAL TRANSFER SWITCHES:

A. Manual transfer switch shall consist of (2) two mechanically-interlocked molded case circuit breakers, cam-style male connectors, power distribution block and grounding terminals, all housed within a padlockable enclosure.
B. Manual transfer switch enclosure shall be Type 3R, constructed of continuous seam-welded, powder coated galvanneal steel. The main access shall be through an interlocked, hinged door that extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via cable entry openings in the bottom of enclosure. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication; color shall be light gray RAL 7038.
C. Cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Cam-style male connectors shall be provided for each phase and for ground, and shall also be provided for neutral. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. The neutral cam-style male connectors, if required, shall be factory wired to a power distribution block. None of the cam-style male connectors shall be accessible unless both molded case circuit breakers are in the "OFF" position and the main access door is open.
D. A power distribution block shall be provided for load-side field wiring. The power distribution block shall be factory wired to the molded case circuit breakers.
E. Molded case circuit breakers shall be UL Listed and the short circuit interrupt rating shall be a minimum of 35kAIC at 480VAC. Trip rating of the molded case circuit breakers shall be as shown on the drawings. One molded case circuit breaker shall be fed from permanent fix mounted generator set; the other molded case circuit breaker shall be fed from the cam-style male connectors to supply power from a portable generator. Both molded case circuit breakers shall include UL Listed door-mounted operating mechanisms, preventing the opening of the main access door unless both breakers are in the "OFF" position. Both molded case circuit breakers shall be mounted behind a deadfront panel. The load-side of the molded case circuit breakers shall not be energizable unless the main access door is closed and one of the molded case circuit breakers is in the "ON" position. The (2) molded case circuit breakers shall be safety interlocked by mechanical means to ensure that only one breaker can be closed at any given time.
F. Manual transfer switch shall be suitable for use as service equipment in the USA.

PART 3 - EXECUTION

3.0 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.1 INSTALLATION:

A. Prior to installation of manual transfer switches, Contractor shall examine the areas and conditions under which the manual transfer switch is to be installed and notify the Engineer in writing if unsatisfactory conditions exist.

B. Manual transfer switch shall be installed as shown on the drawings and per the manufacturer's written instructions. In addition, the installation shall meet the requirements of local codes, the National Electrical Code and National Electrical Contractors Association's "Standard of Installation".

C. Conduit entry into the manual transfer switch shall be by Contractor; Contractor shall furnish and install listed watertight conduit hubs, as manufactured by MYERS or T&B, for each conduit entry on the manual transfer switch. The incoming hub size shall match the conduit size for feeders and ground as shown on the drawings. The outgoing hub size shall match the conduit size for loads and ground as shown on the drawings. Hubs shall be properly installed and tightened to maintain Type 3R integrity of the manual transfer switch enclosure.

D. Contractor shall terminate feeder conductors, load conductors and ground per the manufacturer's instructions. Use copper wire only for all conductors and grounds. All field wiring terminations shall be torqued as required per the instructions on the manual transfer switch's power distribution block, circuit breaker & ground lug.

3.2 FIELD TESTING:

A. Prior to energizing manual transfer switch, the Contractor shall perform the following checks and tests as a minimum:

1. Verify mounting and connections are complete and secure.
2. Verify internal components and wiring are secure.
3. Perform continuity check of all circuits.
4. Perform 1,000 VDC megger test on feeder, load and ground cables.
5. Verify deadfront is secure.
6. With the manual transfer switch deadfront in place and the main access door closed and properly latched, actuate both Operator Mechanisms; verify only (1) breaker at a time can be turned to the "ON" position.
7. Confirm operation of the manual transfer switch ground receptacle by attaching a plug to the manual transfer switch ground receptacle and then verify that the plug is grounded to the facility ground.
8. With generator power applied, confirm operation of manual transfer switch by following directions on main access door.

END OF SECTION 26 36 23.2

SECTION 26 41 13 - LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Drawings and General Provisions of the Contract, including, but not limited to General and Supplementary Conditions and Division 1 Specification Sections apply to all the work specified in this Division and its sections.

B. This Division is a part of the entire set of Contract Documents and shall be coordinated with the applicable provisions of the other parts. The following requirements clarify, amend or are in addition to the requirements set forth under the General Conditions and Division 1.

1.2 REFERENCES

A. In this Article, list only references that are used within other portions of this Section. Use the full title of the standard. If paragraphs containing these references are deleted in the text of the edited section, delete references here accordingly.

B. Lightning Protection Institute (LPI):
1. LPI 175, Lightning Protection Institute Installation Code.

C. National Fire Protection Association (NFPA):
1. NFPA 780, Lightning Protection Systems.

D. Underwriters Laboratories (UL):
1. UL 96, Lightning Protection Components.
2. UL 96A, Installation Requirements for Lightning Protection Systems.

1.3 RELATED SECTIONS

A. Related Sections include the following:
1. Division 07 – Metal Roof Panels
2. Division 07 – Snow Guards
3. Division 10 – Bird Control
4. Section 26 05 26 Grounding and Bonding
5. Section 26 43 13 Surge Protection Device
6. Section 01 40 00 Quality Assurance and Control

1.4 SUMMARY

A. This Section specifies the lightning protection system for the building(s) or structure(s). This system provides safety for the building and occupants by preventing damage to the structure caused by lightning. The design of this system is to be in strict accordance with this section of the specification and all contract drawings that apply.

B. The work covered under this section of the specifications consists of furnishing labor, materials and services required for the completion of a functional and unobtrusive UL Master Label lightning protection system approved by the architect and engineer.

C. A firm actively engaged in the installation of Certified lightning protection systems and listed with Underwriters' Laboratories, Inc., and the Lightning Protection Institute shall install the system.

D. UL certification/labeling require inspection by their third-party field staff after completion of the installation. Contractor shall arrange for all required UL inspections, and pay all associated costs, and required fees for obtaining a UL Master label for the lightning protection system. Upon completion of the lightning protection installation, the contractor shall provide to the owner an as-built drawing of the

system, along with copies of the LPI or U/L Certificates of completion.

1.5 SYSTEM DESCRIPTION

A. The entire lightning protection system shall be designed and installed in accordance with:
1. Lightning Protection Institute (LPI) Standard #175
2. National Fire Protection Assoc. (NFPA) Document #780
3. Underwriters' Laboratories, Inc. (U/L) Standard #96A

1.6 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.

B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.

C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
1. Air Terminals
2. Ground Rods
3. Wire and Cable
4. Mounting Bases
5. Mechanical Fasteners
6. Adhesives
7. Connectors
8. Exothermic welds
9. Accessories

D. Shop drawings:
1. Shop drawings showing the type, size, and locations of all equipment, grounds, cable routings, and other items required to provide a complete and operational lightning protection system.
2. Provide coordination shop drawing with metal roof panel system, bird control, snow guards, and gutter system. Coordinate roof penetrations, conceal vertical drops so they are not visible, and provide weather tight installation.
   a. The lightning protection layout plan shall be prepared to scale using architectural backgrounds. It shall include all features of the roof and roof mounted equipment. Actual locations for all air terminals, conductors, risers and ground rods shall be shown. Layout drawing shall be minimum 1/8"=1'-0" scale with enlarged plans or details to fully depict the proposed installation. Indicate location(s) of connection (bonding) of lightning protection system to building grounding electrode system.
   b. Details of proposed method of concealing conductors.
   c. Details of proposed methods of fastening.
   d. Details of any proposed penetrations.
3. Lightning protection system manufacturer's qualifications.
4. Lightning protection system installer's qualifications

E. Sustainability / Environmental Submittals: Show evidence including, but not limited to the following:
1. Recycled content – documentation showing product supports pre and post – consumer content.
2. Indoor Environmental Quality – product in VOC compliant in the state and jurisdiction the project is located.
3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
4. Comply with recycling program and waste management procedures.

F. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 1, including but not limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES;
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.7 RECORD DOCUMENTS

A. Upon completion of the installation, submit the following:
   1. As-built shop drawings for the lightning protections system.
   2. UL Master Label.

B. Complete shop drawings shall be submitted to the architect and engineer for approval prior to commencement of the installation. The shop drawing will show the extent of the system layout designed for the structure along with details of the products to be used in the installation.

1.8 PERFORMANCE REQUIREMENTS

A. Provide a complete, functional and unobtrusive lightning protection system as specified herein.
   1. Provide the standard product of a manufacturer regularly engaged in the production of lightning protection systems.
   2. Observe the limitations on areas of usage for aluminum cables and for copper and aluminum materials together as outlined in NFPA 780 and LPI 175.
   3. Install all systems in conformance with UL 96A requirements.
   4. Protect equipment on stacks and chimneys from corrosion, and size the equipment in accordance with LPI and UL requirements.

B. Install all equipment in a neat workmanlike manner in the most inconspicuous manner possible.
C. Coordinate work with building grounding electrode system.
D. Provide a lightning protection system that conforms to the requirements of the Lightning Protection Institute and Underwriter's Laboratories Standards for lightning protection systems.
   1. Provide LPI System Certification.
   2. Provide Underwriters' Laboratories, Inc. inspected, approved, and properly labeled equipment; and furnish a UL Master Label for the system.

E. All work shall be concealed from view to the greatest extent possible. All down leads shall be concealed. No conduit or cable will be permitted to be installed on any exposed vertical face of the building or exposed on any exterior soffits. The locations of down leads shall be identified, coordinated and submitted for approval prior to the construction of the building to establish paths for conduits which need to be concealed or embedded. Any work installed on the face of the building will be removed and relocated at the Contractor's cost. A pre-installation conference shall be conducted for the work of this Specification Section. Coordinated shop drawings are required to determine rough in and routing of all system wiring.

1.9 QUALITY ASSURANCE

A. The contractor shall furnish a U/L Certificate upon completion of the installation.
B. The system installation shall be made under the supervision of an LPI Certified Master Installer, and the LPI System Certification shall be delivered upon completion of the installation.
C. Authority's Maintenance Department (AMD) Quality Control
   1. Contractor shall notify the Engineer and AMD Liaison 30 days prior to commencing work.

2. Contractor shall be responsible to request and secure AMD pre-functional and functional checklists as well as any other required documents.
3. Electronic and hardcopy transmission of completed checklists and documents are required prior to final inspection.

PART 2 - PRODUCTS:

2.1 STANDARD

A. All materials shall comply in weight, size, and composition with the requirements of the UL 96 Materials Standards. All equipment shall be UL listed and properly labeled. The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment. Equipment shall be the manufacturer's latest approved design of construction to suit the application where it is to be used in accordance with accepted industry standards and with NFPA, LPI, & UL requirements.

B. Basis of design Warren Lightning Rod Company.

C. Acceptable Manufacturers:
1. Warren Lightning Rod Company
2. East Coast Lightning Equipment, Inc.
3. Thompson Lightning Protection, Inc.
4. Or Approved Equal

2.2 MATERIALS

A. Class I materials shall be used for systems on structures not exceeding 75 feet in height and Class II materials shall be used for systems on structures exceeding 75 feet above grade.
1. Class I
   a. Air Terminals: Min. 3/8 inch (9.5 mm) diameter, solid.
   b. Main Conductors: Min. 187 pounds per 1000 feet, 17 AWG strand size, 59,500 cir. mils (278 g/m, 29 mm2) total cross sectional area.

2. Class II
   a. Air Terminals: Min. 1/2 inch (12.7 mm) diameter, solid.
   b. Main Conductors: Min. 375 pounds per 1000 feet, 15 AWG strand size, 115,000 cir. mils (558 g/m, 58 mm^2) total cross sectional area.

B. Copper shall be of the grade ordinarily required for commercial electrical work, generally designated as being 95 percent conductive when annealed. Aluminum conductors shall be of electrical grade aluminum.

C. Lightning protection materials shall be coordinated with building construction materials to assure compatibility. Aluminum lightning protection materials shall not be embedded in concrete or masonry, installed on or below copper surfaces, or used for the in-ground system. Copper lightning protection materials shall not be installed on aluminum surfaces. Copper system components within 2 feet of chimney exhausts shall be tin coated to protect against deterioration.

D. Strike termination devices shall be provided to place the entire structure under a zone of protection as defined by the Standards. Air terminals shall project a minimum of 10 inches above protected areas or objects. Air terminals shall be located within 2 feet of exposed corners and roof edges.

E. Metallic bodies having a thickness 3/16" or greater may serve as strike termination devices without the addition of air terminals. These bodies shall be made a part of the lightning protection system by connection(s) according to the Standards using main size conductors and bonding fittings with 3 square inches of surface contact area.

F. Cable conductors shall provide a two-way path from strike termination devices horizontally and downward to connections with the ground system. Cable conductors shall be free of excessive splices and sharp bends. No bend of a conductor shall form a final included angle of less than 90 degrees nor have a radius of bend less than 8 inches. Structural elements and design features shall be used whenever

possible to minimize the visual impact of exposed conductors.

G. Cable down conductors shall be concealed within the building construction enclosed within PVC conduit from roof to grade level. Down conductors shall be spaced at intervals averaging not more than 100 feet around the protected perimeter of the structure. In no case shall any structure have fewer than two down conductors. Where down conductors are exposed to environmental hazards at grade level, guards shall be used to protect the conductor to a point 6 feet above grade.

H. Exposed cable conductors shall be secured to the structure at intervals not exceeding 3 feet – 0 inches. Fasteners, nails, screws, or bolts shall be of suitable configuration for the intended application and of the same material as the conductor or of electrolytically compatible materials. Galvanized or plated steels are not acceptable.

I. Connectors and splicers shall be of suitable configuration and type for the intended application and of the same material as the conductors or of electrolytically compatible materials.

J. Ground terminations suitable for the soil conditions shall be provided for each downlead conductor. Where the structural steel framework is utilized as main conductors for the system, perimeter columns shall be connected to the grounding system at intervals averaging 60 feet or less on the protected perimeter. For any structure in excess of 60 ft. in vertical elevation above grade, a ground loop interconnecting all ground terminals and other building grounded systems shall be provided.

K. Common interconnection of all grounded systems within the building shall be accomplished using main size conductors and fittings. Grounded metal bodies located within the calculated bonding distance as determined by the formulas of the Standards shall be bonded to the system using properly sized bonding conductors.

L. Surge suppression shall be provided at every system entrance to the structure to prevent massive lightning overvoltages from entering the structure. Additional surge protection for internal electronic equipment may be determined through cost-benefit analysis by a trained engineer.

PART 3 - EXECUTION:

3.1 STANDARD

A. The installation shall comply with the requirements of NFPA 780, UL 96A, and LPI 175.

3.2 ACCEPTABLE INSTALLERS

A. The installing contractor company shall be listed with the Lightning Protection Institute, and Underwriters' Laboratories, Inc. The installation contractor shall have personnel on staff Certified by the LPI as a Master Installer or Master Installer – Designer of lightning protection systems. LPI qualified staff shall provide supervision of the installation to the Standards.

B. Member of the Lightning Protection Institute (LPI).

3.3 INSTALLATION

A. The installation of the lightning protection system components shall be done in a neat and workmanlike manner.

B. Roof penetrations required for down conductors or for connections to structural steel framework shall be made using through-roof assemblies with solid bars and appropriate roof flashings. The roofing contractor shall furnish the methods and materials required at roofing penetrations of the lightning protection components and any additional roofing materials or preparations required by the roofing manufacturer for lightning conductor runs to assure compatibility with the warranty for the roof.

C. UL certification requires inspection by their third-party field staff after completion of the installation. Upon completion of the lightning protection installation, the installing contractor shall provide to the owner an as-built drawing of the system, along with copies of the LPI or U/L Certificates of completion.

D. If the protected structure is an addition to or is attached to an existing structure that does not have a lightning protection system, the contractor shall certify that the system installed complies with the requirements of the Standards, and advise the owner of the lightning protection work required on the

existing structure to obtain full certification for the structure. If the existing structure does have a lightning protection system, the contractor shall advise the owner of any additional work required on the existing system to bring it into compliance with current Standards and thus qualify for U/L certification.

END OF SECTION 26 41 13

SECTION 26 43 13 – SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Surge Protection Device (SPD) covered under this section includes distribution panel surge protection devices (Type 2 also known as TVSS).
B. Provide SPD located at Distribution and Branch Panels as indicated on drawing.
C. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devises.

1.2 RELATED SECTIONS

A. Related Sections include the following:
   1. Section 01 40 00 Quality Assurance and Control
   2. Section 26 05 26 Grounding & Bonding

1.3 SUBMITTALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in 013300 SUBMITTAL PROCEDURES.
B. Product Data General: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
   1. Product Data: Provide information for each type of product specified.

C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work to describe the work.
   1. Manufacturer to propose spacing and layout of supporting devices including heights, spacing, and frequency.

D. Maintenance data.
E. Warranties: Sample of special warranties.
F. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

G. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.4 QUALITY ASSURANCE

A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
   1. ANSI/UL 1449 Third Edition: UL Standard for Surge Protection Devices
   2. UL 1283
   3. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
   4. ANSI/IEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
   5. IEEE 1100 Emerald Book
   6. NEMA LS-1, 1992-(R2000) Low Voltage Surge Protection Devises.
   7. National Fire Protection Association (NFPA 70: National Electrical Code

B. Submittals/Quality Assurance – Submit the following
   1. Shop Drawings complete with all technical information. Package must include unit dimensions, installation instructions (detailed), Maintenance Manuel, recommended replacement parts list, wiring configuration.
   2. Copies of Manufacturer's catalog data, technical information and specifications on equipment proposed for use.
   3. Copies of documentation stating that the Surge Protection Device is listed from a Nationally Recognized Testing Laboratory (NRTL) (UL, ETL, etc) and are tested and multi-listed to UL 1449 and UL 1283.
   4. Copies of actual let through voltage data in the form of oscillograph results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.
   5. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50kHZ and 100MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.
   6. Copies of Surge Fuse Testing. Each unit shall be surge tested with fusing in series to verify that a transient of maximum surge current capacity/magnitude is fully suppressed without fuse failure, operation or degradation per NEMA LS1-1992 R2000) Section 3.9
   7. Copies of test reports from a recognized independent testing laboratory, capable of producing 200KS surge current waveforms, verifying the suppressor components can survive published surge current rating on both a per mode and per phase basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA) Test data on an individual module is not acceptable.
   8. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

C. Authority's Maintenance Department (AMD) Quality Control
   1. Contractor shall notify the Engineer and AMD Liaison 30 days prior to commencing work.
   2. Contractor shall be responsible to request and secure AMD pre-functional and functional checklists as well as any other required documents.
   3. Electronic and hardcopy transmission of completed checklists and documents are required prior to final inspection.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Atlantic Scientific Corporation, Powersmiths Pro Series, Joslyn, Advanced Protection Technologies, Inc., or equal.
B. Basis of design Atlantic Scientific Corporation – ZoneDefender PRO Series

2.2 SERVICE ENTRANCE SUPPRESSORS

A. General

1. The A.C. Voltage Surge Protective Devices shall be a high speed, high current solid-state device designed to protect electronic equipment and electrical systems from transient over voltages. It shall limit the magnitude of a transient overvoltage present on the AC service or distribution power lines. The suppressor shall provide continuous bi-polar, bi directional, non-interrupting protection and be capable of instant automatic reset with no degradation in protection capabilities. The suppressor shall be solid state, utilizing 40mm metal oxide arrestors (MOV's). Gas tubes are not acceptable. It shall start to suppress the transient at a minimum of 115% of the peak voltage of the sinewave. The suppressor assembly shall be installed in parallel of the service main disconnect, distribution or branch panel main lugs. Connect the suppressor to over current protection sized with an AIC rating equal to or greater than the panel rating. The suppressor shall be contained in an enclosure appropriate for the environmental application.

B. Electrical Performance

1. ANSI/IEEE Testing Minimum Requirements

	SVR UL 1449 2nd	VPR UL 1449 3rd	CAT B 6kV/3kA	CAT C High 20kV/10kA
480Y/277	800V	1200V	776V	904V
208Y/120	400V	700V	416V	528V

C. SPD specifics:

1. The surge protection device shall be permanently wired through an over current device (specific size shall be specified by the manufacturer) installed in the service entrance electrical equipment (rated with the same electrical characteristics of the panel) with leads as short as possible and not to exceed 18 inches.

2. Surge Protection Device Description - Modular Design with field replaceable modules and the following features and accessories:
   a. Fabrication using bolted compression lugs for internal wiring
   b. Replaceable bolt down modules per phase. The use of single "Brick" Module and/or "Plug In" type module designs will not be accepted.
   c. Arrangement with wire connections to phase buses, neutral bus, and ground bus
   d. 200,000 AIC Fused Rotary Disconnect
   e. Remote Audio/ Visual Alarm Panel
   f. UL Listed 1283 Extended Power Range Filter
   g. Green/Red LED Indicator lights for power and protection status.
   h. Green = Power On / Protection Present Red = Failure
   i. Normally Open / Normally Closed Form C Dry Contacts
   j. Surge Event Counter

3. Peak Single-Impulse Surge Current Rating shall be 240kA per phase
4. Standard unit housings shall be 16 gauge painted steel and match the NEMA rating of the panel board.
5. Standard unit warranty must be for at least 15 years and be stated in the manufacturer's literature.

2.3 DISTRIBUTION PANEL SUPPRESSORS

A. General

1. The A.C. Voltage Surge Protective Devices shall be a high speed, high current solid-state device designed to protect electronic equipment and electrical systems from transient over voltages. It shall limit the magnitude of a transient overvoltage present on the AC service or distribution power lines. The suppressor shall provide continuous bi-polar, bi directional, non-interrupting protection and be capable of instant automatic reset with no degradation in protection capabilities. The suppressor shall be solid state, utilizing 40mm metal oxide arrestors (MOV's). Gas tubes are

not acceptable. It shall start to suppress the transient at a minimum of 115% of the peak voltage of the sinewave. The suppressor assembly shall be installed in parallel of the service main disconnect, distribution or branch panel main lugs. Connect the suppressor to over current protection sized with an AIC rating equal to or greater than the panel rating. The suppressor shall be contained in an enclosure appropriate for the environmental application.

B. Electrical Performance
1. ANSI/IEEE Testing Minimum Requirements

	SVR UL 1449 2nd	VPR UL 1449 3rd	CAT B 6kV/3kA	CAT C High 20kV/10kA
480Y/277	700V	1000V	825V	950V
208Y/120	330V	600V	456V	550V

C. SPD specifics:
1. The surge protection device shall be permanently wired through an over current device (specific size shall be specified by the manufacturer) installed in the service entrance electrical equipment (rated with the same electrical characteristics of the panel) with leads as short as possible and not to exceed 18 inches.
2. Surge Protection Device Description - Modular Design with field replaceable modules and the following features and accessories:
   a. Fabrication using bolted compression lugs for internal wiring
   b. Replaceable bolt down modules per phase. The use of single "Brick" Module and/or "Plug In" type module designs will not be accepted.
   c. Arrangement with wire connections to phase buses, neutral bus, and ground bus
   d. UL Listed 1283 Extended Power Range Filter
   e. Green/Red LED Indicator lights for power and protection status.
   f. Green = Power On / Protection Present Red = Failure
   g. Normally Open / Normally Closed Form C Dry Contacts
3. Peak Single-Impulse Surge Current Rating shall be 100kA per phase
4. Standard unit housings shall have a transparent front cover for complete visual inspection and monitoring the status of protection for each module, any onboard diagnostics, module configuration, and wiring configuration.
5. Standard unit housings shall be non-metallic and meet NEMA 1, 2, 3, 3S, 4, 4X, 12 and 13 classifications
6. Standard unit warranty must be for at least 15 years and be stated in the manufacturer's literature.

2.4 BRANCH PANEL SUPPRESSORS

A. General
1. The A.C. Voltage Surge Protective Devices shall be a high speed, high current solid-state device designed to protect electronic equipment and electrical systems from transient overvoltages. It shall limit the magnitude of a transient overvoltage present on the AC service or distribution power lines. The suppressor shall provide continuous bi-polar, bi directional, non-interrupting protection and be capable of instant automatic reset with no degradation in protection capabilities. The suppressor shall be solid state, utilizing metal oxide varistors (MOV's). Gas tubes are not acceptable. It shall start to suppress the transient at a minimum of 115% of the peak voltage of the sinewave. The suppressor assembly shall be installed in parallel of the service main disconnect, distribution or branch panel main lugs. Connect the suppressor to over current protection sized with an AIC rating equal to or greater than the panel rating. The suppressor shall be contained in an enclosure appropriate for the environmental application.

B. Electrical Performance
1. ANSI/IEEE Testing Minimum Requirements

	SVR UL 1449 2nd	VPR UL 1449 3rd	CAT B 6kV/3kA	CAT C High 20kV/10kA
480Y/277	800V	1000V	890V	1200V
208Y/120	400V	500V	435V	730V

C. Surge Protection Devices details:
1. The surge protection device shall be permanently wired through an overcurrent device (specific size shall be specified by the manufacturer) installed in the service entrance electrical equipment (rated with the same electrical characteristics of the panel) with leads trimmed as short as possible and not to exceed 18 inches.
2. Surge Protection Device Description - Non-Modular Design with the following features and accessories:
   a. 200,000 AIC Fused
   b. Built in Audible Alarm
   c. UL Listed 1283 Extended Power Range Filter
   d. Green/Red LED Indicator lights for power and protection status.
   e. Green = Power On / Protection Present Red = Failure
   f. Normally Open / Normally Closed Form C Dry Contacts
3. Peak Single-Impulse Surge Current Rating shall be 80kA per phase
4. Standard unit housings shall be metallic in construction and meet NEMA 1,2,3,3S,4,4X,12, and 13 classifications
5. Standard unit warranty must be for at least 10 years and be stated in the manufacturer's literature.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify General Contractor in writing, with copies to the Owner's Representative, Owner, and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to General Contractor written confirmation, with copies to the Owner's Representative, Owner, and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 APPLICATION OF SPD

A. General
1. Apply SPD on the load side of the first main disconnect at the electrical service entrance switchboard and on the load side of the main overcurrent device at the electrical distribution panelboard.
2. Coordinate system voltage, wiring configuration, and location as shown on project drawings.

3.3 INSTALLATION OF SPD

A. Service Entrance
1. Connect the SPD to a 60A Breaker with #6 AWG minimum conductors, #4 AWG maximum (for ease of dressing), to the Service Entrances panel being protected. The conductors are to be as short and straight as practically possible and shall not exceed 18 inches in length. The SPD shall be installed following the manufacturer's recommended practices and in compliance with all applicable codes.

B. Distribution Panels
   1. Connect the SPD to a 60A or 30A (whichever is specified by the manufacturer for that model) with #8 AWG minimum conductors, #4 AWG maximum (for ease of dressing), to the Distribution panels being protected. The conductors are to be as short and straight as practically possible and shall not exceed 18 inches in length. The SPD shall be installed following the manufacturer's recommended practices and in compliance with all applicable codes.

C. Branch Panels
   1. Install the SPD to with #10 AWG provided from the manufacturer to the Branch panels being protected. The conductors are to be kept as short and straight as practically possible and shall not exceed 18 inches in length that is provided. The SPD shall be installed following the manufacturer's recommended practices and in compliance with all applicable codes.

3.4 WARRANTY

A. Warranty on defective material and workmanship shall be for 10 years.

END OF SECTION 26 43 13

SECTION 26 50 00 - LIGHTING FIXTURES AND ACCESSORIES

PART 1 - GENERAL

1.1 DISCRIPTION

A. Provide fixtures as indicated in schedule on drawings and further specified. Fixtures to bear label of Underwriters' Laboratories and be installed true and plumb, left clear and free from grease and fingerprints. Damage or spoiling of ceiling to be repaired and/or replaced at no cost to the Owner. Lighting fixtures to be complete with all necessary mounting hardware, lamps, ballasts, starters, and other necessary equipment. Where fixture type is not noted, furnish the same type noted in similar areas, mounted individually or continuously as indicated.

B. The catalog numbers in Fixture Schedule on drawings includes the lighting fixture descriptions, fixture manufacturers, and corresponding model numbers. The part numbers shown on the Lighting Fixture Schedule are intended to indicate the fixture type but do not include all accessories or mounting requirements. Provide fixtures will all accessories as described in the fixture schedule descriptions and remarks and mounting hardware to match the intended installation. Coordinate with Architectural reflected ceiling plans and ceiling types. The Lighting Fixture Schedule shown on the drawing indicates the approved fixture by manufacturer and catalog number. Equivalent fixtures by other approved manufacturers may be submitted for approval. The Owner shall be the final authority in determining the equivalency of the substituted fixture.

C. Where drawings show only one (1) "Type" letter adjacent to a continuous row of fixtures or adjacent to a few fixtures in the room, it means that the designation is applicable to every fixture symbolized in each group.

1.2 DESIGN REQUIREMENTS

A. Design Criteria:
1. The Lighting Fixture Schedule on the Contract Drawings constitutes the basis of the lighting design for this Contract, but may not indicate the special design details required.
2. Provide lighting fixtures meeting the requirements of the basis of the lighting design for this Contract, and which have the special details specified in this Section.

1.3 STANDARDS

A. The system shall be designed in accordance with applicable portions of the following standards:
1. American National Standards Institute (ANSI C57.110)
2. Institute of Electrical and Electronic Engineers (IEEE 519-1992) (C62.41-1991)
3. National Electrical Manufacturers Association (NEMA PE-1)
4. National Electric Code
5. National Fire Protection Association (NFPA 70) (NFPA 101) (NFPA 111)
6. Underwriters Laboratories (UL 924)
7. Federal Communications Commission (FCC Part 15, Sec. J, Class A)
8. Federal Aviation Administration (FAA-G-201e)
9. Listed UL Standards UL 924 Emergency Lighting Equipment with 90 minutes, or UL 924 Auxiliary Lighting and Power Equipment (UL 924A) for other than 90 minutes battery backup, or C-UL 924 Emergency Lighting and Power Equipment with 30 minutes, listed to CAN/CSA-C22.2 No. 141-02, Canadian Electrical Code, Part I, and the National Building Code of Canada.

1.4 RELATED SECTIONS

A. Related Sections include the following:
1. Lighting Fixture Schedule
2. Occupancy Schedule

3. Electrical Details
4. Section 019100 – Commissioning
5. Section 01 40 00 Quality Assurance and Control

1.5 SUBMITALS

A. Procedure: Comply with submittal requirements indicated below and as stipulated in Section 013300, Submittals.

B. Provide evidence of testing agency verification, listing and labeling either by printed mark on the data sheet or by a separate listing card.

C. Product Data: Submit manufactures product literature, technical specifications, application instructions and similar data for each product specified below. Clearly indicate the proposed usage of each product.
   1. Product Data on all Lighting Fixtures
   2. Photometric Data
   3. Product Data Lighting Inverter
   4. Occupancy Sensors and controls
   5. Emergency By-pass Relay
   6. Lighting Controls Wiring Diagrams

D. Shop Drawings:
   1. Submit Shop Drawings and manufacturer's installation instructions to show details of assemblies and sub-assemblies, and specially-fabricated supporting and fastening devices
   2. Submit bills of material for the fixtures and their appurtenances.
      a. Reference the bills of material to the Shop Drawings.
      b. Provide bills of material consisting of itemized lists of the parts required (i.e. ballast capacitor igniter, and other similar item descriptions).
      c. Identify each part with a part number and/or manufacturer number.
   3. Submit Shop Drawings and manufacturer's installation instructions to show details of assemblies and wiring diagrams for lighting inverters.
   4. Provide the following information when substitutions are submitted for fixtures identified in the Fixture Schedule:
      a. Calculations showing the substituted fixtures provide equivalent illumination including foot candle level, visual comfort performance, glare and energy usage.

E. Sustainability / Environmental Submittals: Show evidence including but not limited to the following:
   1. Recycled content – documentation showing product supports pre and post - consumer content.
   2. Indoor Environmental Quality - product is VOC compliant in the state and jurisdiction the project is located.
   3. Proposed products are manufactured within a 500-mile radius of the project site and are considered to be a locally produced material which supports regional materials and resources.
   4. Comply with recycling program and waste management procedures.

F. Contract Closeout Submittals: Comply with the applicable sections noted in DIVISION 01, including but limited to the following:
   1. Requirements of 017700 CLOSEOUT PROCEDURES.
   2. Submission of maintenance instructions described in 017823 OPERATION AND MAINTENANCE DATA;
   3. Record documents as described in 017839 PROJECT RECORD DOCUMENTS;
   4. Demonstration and training requirements indicated in 017900 DEMONSTRATION AND TRAINING.

1.6 AUTHORITY'S MAINTENANCE DEPARTMENT (AMD) QUALITY CONTROL

A. Contractor shall notify the Engineer and AMD Liaison 30 days prior to commencing work.
B. Contractor shall be responsible to request and secure AMD pre-functional and functional checklists as well as any other required documents.
C. Electronic and hardcopy transmission of completed checklists and documents are required prior to final inspection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The manufacturers of the fixtures that were used as the basis for the lighting design for this Contract are listed in the Fixture Schedule on the Contract Drawings.
   1. Fixture descriptions and corresponding manufacturer's style numbers are shown in the Fixture Schedule.
   2. Additional manufacturers who can provide products comparable to those listed in the Fixture Schedule including warranties may submitted for approval.

2.2 MATERIALS

A. Fixture Support Devices and Fasteners:
   1. In addition to the supporting devices and fasteners, provide suspension accessories, canopies, casing, sockets, holders, reflectors, plaster frames, recessed boxes and similar items required to support the lighting equipment and luminaires as specified or indicated.
   2. Fixtures shall be supported independently of suspended ceilings. Provide minimum two support means for each fixture fastened to building structure and independent of the ceiling support system.

2.3 MANUFACTURED UNITS

A. Light Fixtures:
   1. Provide those fixtures indicated on the Lighting Fixture Schedule on the Contract Drawings or approved substitutions.
   2. Provide the housing of each fixture with a separate, factory-installed grounding device and ground conductor.
   3. Provide the proper type of lamps for the lighting fixtures scheduled on the Contract Drawings or indicated on the approved Shop Drawings.
   4. Provide luminaire brackets fabricated to be compatible with the configuration of the luminaire.
   5. Supply pendant stems, special mounting supports and hardware, and miscellaneous materials and incidentals required to install the lighting and emergency battery unit products in place.

2.4 EMERGENCY LIGHTING CONTROL UNIT

A. Basis of design-WattStopper's ELCU-200 Emergency Lighting Control Unit.
B. Emergency Lighting Control Unit is a self-contained device that allows any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area of the building. Emergency lighting control units shall be provided in all areas of the building to control the designated emergency lights in each area through the area lighting control device.
C. The ELCU-200 monitors a single circuit that provides normal lighting to an area. As long as normal power is present, the ELCU-200 permits lighting control devices (e.g., occupancy sensors, panels, dimmers, or wall switches) to control the emergency lighting fixtures as well as the general lighting. If power is lost for any reason, including the tripping of a single branch circuit breaker, the ELCU-200 will force on the emergency fixtures for that area. The ELCU-200 can be wired either as a control device, so

that emergency lighting follows the control of normal lighting, or as a bypass device to shunt emergency power around a control device (e.g., a dimmer) when normal power fails.

2.5 OCCUPANCY SENSORS

A. Design Criteria:
1. The Occupancy Sensor Schedule on the Contract Drawings constitutes the basis of the design for this Contract, but may not indicate the special design details required.
2. Provide Occupancy Sensors meeting the requirements of the basis of the design for this Contract, and which have the special details specified in this Section.

B. Sensors shall have standard 5 year warranty and shall be UL and CUL listed.

2.6 CENTERLIZED EMERGENCY LIGHTING INVERTER

A. DESCRIPTION
1. This specification defines the electrical and mechanical characteristics and requirements for a stored electrical energy, uninterruptible, emergency power supply system. The system as specified herein includes all the components required to deliver reliable, high quality uninterruptible power for emergency illumination and related life safety equipment. The system shall incorporate an online, dual conversion, advanced DSP controlled, high frequency, IGBT PWM rectifier/charger and inverter, high speed automatic bypass transfer device, battery charging system, energy storage battery platform, a diagnostic monitoring display panel, and all the related hardware components and software to facilitate a functional centralized system. The emergency power supply system shall provide immunity from all line disturbances and power interruptions. The system includes an uninterrupted, normally on output power section and a normally off standby output power section, thus enabling compatibility with emergency lighting fixtures operating in normally on and standby mode(s). A self-diagnostic monitoring alarm system continuously advises of system status and battery condition.

B. Product Data:
1. The manufacturer shall supply documentation for the installation of the system, including wiring diagrams and cabinet outlines showing dimensions, weights, BTUs, input/output current, input/output connection locations and required clearances.
2. Factory test results shall be provided to show compliance with the requirements. The manufacturer shall include battery test documentation which demonstrates compliance with the specified minimum emergency reserve with full rated KW load.
3. The supplier shall furnish (6) equipment submittal copies. Submittals shall be specific for the equipment furnished and shall include as-built information.

C. Manufacturers
1. The basis of design is the UltraLITE Model ELC centralized emergency lighting inverter system, manufactured by Controlled Power Company.

D. Manufactured Units
1. The system shall be designed and manufactured to assure maximum reliability, serviceability and performance. All control devices and system electronics shall be accessible via the front inverter cabinet for rapid service or replacement. The diagnostic monitor panel display shall be mounted on the front of the system for easy observation of system status and battery condition. The system is to be furnished with an internally located AC input circuit breaker and up to 12 output circuit breakers as specified. The battery and DC conductors shall be DC circuit breaker protected. All conductors and transformer windings shall be copper constructed. The installed system shall be floor mounted and wall secured, constructed of steel, with the inverter controls, bypass, and breakers being front accessible through a hinged door, requiring a hand tool for access. The

installed inverter cabinet shall be designed to meet NEMA 2 standards, rated for indoor use. Cabinet dimensions shall not exceed (22" W x 12"D x 40"H) (22" W x 12"D x 50"H) (22" W x 12"D x 74.5"H).

2. The system shall operate in accordance with requirements as specified herein to support any combination of fluorescent ballast fixtures, incandescent lamps, electronic and high power factor fluorescent ballasts, LED or HID fixtures or other approved loads up to the rating of the system. "Normally on" and "Normally off" AC output bus shall be 100% rated and limited only by the system's maximum KW output rating.
3. Normal Operation: The load is supplied with regulated power derived from the normal AC power input terminals through the rectifier charger and inverter. The rectifier charger shall be fully rated to charge the batteries and supply sufficient DC energy for the inverter when under full load. The battery shall be connected in parallel with the rectifier charger output.
4. Uninterrupted Emergency Operation: Upon the failure or unacceptable deviation of commercial AC power, energy will be supplied by the battery through the inverter and continue to supply power to the load without switching loss or disturbance. When power is restored at the AC input terminals of the system, the rectifier charger shall continue to supply power to the load through the inverter and simultaneously recharge the batteries. There shall be no break or interruption of power to the load upon failure or restoration of the commercial AC power.
5. Standby Emergency Operation: Upon the failure or unacceptable deviation of commercial AC power or upon a remote input "command on signal", the standby, normally off AC output section of the system shall become energized, thus providing emergency power for standby lighting fixtures which are required to illuminate only in the event of emergency. User-adjustable settings shall include transfer on delay time (0 to 8 seconds), transfer off delay time (0 to 15 minutes), and a soft start control (0 to 172 cycles) to accommodate the high inrush current associated with energizing normally off emergency lights, compatible with various lighting types and manufacturers.
6. Automatic Bypass Operation: The system shall include a high speed automatic bypass for fault clearing, for instantaneous overload conditions and/or to connect the load to the normal utility source in the event of a system rectifier charger or inverter failure.
7. Manual Bypass Switch: The system shall include an integral inverter bypass switch for use in case of an inverter failure. The switch shall be accessible via the front of the inverter enclosure, through a hinged door, requiring a hand tool for access. When in the bypass position, the switch shall bypass the inverter power control electronics and divert utility power to the inverter's normally on output bus.
8. System Power Output Capability: The stored emergency power supply system output power rating shall be 2000 watts.
9. Battery Time Reserve Capacity: Battery shall be capable of producing emergency power for 90 minutes at full rated watts.
10. Reliability: MTBF 100,000 hours. MTTR, 1 hour typical.
11. System Input Breaker Rating: Input breaker shall be sized to accommodate full rated load, low line input, and maximum recharge current simultaneously. 2000 watt unit – 30A @ 120 VAC or 15A @ 277 VAC.

E. Input Specifications

1. Input Voltage: 120 VAC or 277 VAC.
2. Input Voltage Operating Range: +12% to -15% at full load without battery usage.
3. Extended Range: The unit shall incorporate the use of variable range logic in conjunction with the load percentage to extend the input range up to +12% to -30%, without battery usage, while maintaining a regulated output voltage.
4. Frequency Range: 57.5 hertz to 62.5 hertz.
5. Power Factor: Self correcting to >0.97 (approaching unity).
6. Input Current Harmonics: <5% THD (total harmonic distortion).

F. Output Specifications
1. Output Voltage: 120 VAC or 277 VAC.
2. Sine Wave Voltage: Maximum 3% THD under linear load.
3. Frequency: 60 hertz + 0.5% under full load while in the battery operation mode.
4. Harmonic Attenuation: Reflected load generated harmonics shall be attenuated at the input.
5. Voltage Regulation: +/-2%.
6. Output Power Rating: KVA at 1.0 power factor (unity). KVA = KW

G. Battery Specifications
1. Battery time: 90 Minutes at full rated kilowatt output, UL 924 listed, C-UL 924 listed Battery Type: Integral, valve regulated, sealed lead calcium, maintenance free.
2. Charger: 4 stage, 400 watts, temperature compensated, smart charge.
3. Recharge Time: UL 924, NFPA 101 compliant, 24 hour recharge.
4. Bus Voltage: 72 VDC.

H. Performance Specifications
1. Overload Rating: 1000% for 1 cycle, 500% for 1 second and 150% for 1 minute when fed from AC power source.
2. On Battery Overload Rating: Normally On Bus Output shall be 200% surge rating for 5 cycles, 105% continuous.
3. Normally Off Bus Output with User-Progammable Soft-Start: Adjustable settings shall be provided to limit the high inrush current, associated with energizing normally off emergency lights, to within the inverter's on battery overload rating.
4. Voltage Regulation: The output voltage shall be regulated to within +2% during input voltage changes from +12% to -15% with reference to nominal, and when the output is loaded from no load to full rated load.
5. Reactive Power Correction: Load at .6 pF corrected to > 0.97 at input (automatically correcting).
6. Efficiency: 88% typical under full rated load.
7. Reliability: 100,000 hours MTBF.

I. Environmental Specifications
1. Operating Temperature: 20°C to 35°C for UL 924 Listed models. Optimum battery performance and life shall be achieved at 25°C. Inverter electronics shall be designed for use at 0°C to 40°C.
2. Inverter Storage Temperature: -20°C to 50°C.
3. Battery Storage Temperature: 25°C for 6 months. For each 9°C rise, reduce storage time by half.
4. Relative Humidity: 95% non-condensing.
5. Elevation: 5,000 feet, 1,500 meters.
6. Audible Noise Level: Not greater than 50 dba at 3 feet.
7. Enclosure: NEMA 2, powder-coat painted steel construction, drip-proof, and sealed prohibiting rodent entry.

J. Display Monitor and Diagnostics
1. Display Panel – System shall include a local, front mounted, sealed, LED display panel to indicate system status and battery condition. Display shall include provisions to automatically monitor inverter input voltage normal, inverter input voltage high, inverter input voltage low, inverter on automatic bypass, % load, battery in use, battery full charge, battery low and check battery.
2. Audible Alarm – The display panel includes an audible alarm with alarm silence for system on battery, low battery, check battery, over temperature warning, system fault and inverter overload.
3. Control Functions – Push button for inverter on, fail safe dual push buttons for inverter off, alarm silence push button and push button for manually initiating a system battery test.
4. Communications Port (RS232) – Include a DB9 and USB communications port for remote monitoring access to electrical measurements, system set point programming and system logs.

5. Electrical Measurements (RS232) – Electrical measurements shall include: input voltage L1-neutral, output voltage L1-neutral, output current (amps), output watts, output volt amperes, % load, battery voltage and DC charging current, and output frequency.
6. System Set Points (RS232) – Include provision to program the following: low battery alarm, battery usage, automatic battery tests programmable for 30 day intervals, or 90 day intervals and an annual discharge test. The start date and time of the 30, or 90 day test selected and of the annual test (365 day interval) shall be programmable via the RS232 connection (DB9 or USB port). The time duration of the automatic battery test shall be programmable (30 seconds or 5 minutes).
7. System Log (RS232) – System shall include provisions to log power outages, system overloads and battery test pass/fail results, all with a date and time stamp.
8. Automatic Self-Testing – Systems shall provide a programmable 30 second (UL 924A) or 5 minute automatic battery test that can be programmed to occur every 30, or 90 days.

K. Relay Communications Interface
1. Status / Alarm relay interface normally open contacts shall be provided for optional remote annunciator panel or automatic message dialer. Include potential free, 120 VAC @ .5amps, contacts for inverter on battery, low battery warning, and general alarm.

L. Accessories
1. Include network device SNMP / Ethernet TCP/IP adapter for network communication of inverter system status, electrical measurement data, and automatic battery pass / fail test results with time and date stamp.
2. Include 12 pre-installed, 20 amp, single pole, output circuit breakers for use with normalAC output bus.

M. Warranty
1. The manufacturer shall guarantee all power component and system electronics to be free free from defects in material and workmanship for a period of 2 years following shipment from the factory.
2. Battery warranty shall be 1 year full replacement, 14 year prorated.

N. Serviceability
1. The inverter's power section, including all control cards and system electronics, shall be front-accessible and located behind a secure hinged access door for ease of service or component replacement. An integral inverter bypass switch must be provided. A DC circuit breaker and DC Anderson connector shall be incorporated into the design to facilitate rapid replacement of the batteries via the front of the system enclosure. No side access shall be required. To facilitate inverter diagnostics and programming, a DB9 and USB communications port shall be provided for access to electrical measurements, system set points, and system logs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount fixtures rigidly to construction using the proper type fastenings, bars, devices, frames, canopies, stems, etc., to adapt the fixtures to the structural conditions and to insure a safe, non-hazardous installation.
B. Note the type of construction to which the fixtures are to be attached before ordering same and make certain that all necessary mounting hardware is supplied.
C. Suspended fixtures shall be braced for seismic loads.
D. Where fixtures are mounted on suspended ceilings, provide additional supports from the ceiling grid to the building structure at the four corners of each fixture. The fixture itself shall then be securely fastened to the ceiling grid members with clips designed for this purpose. In areas with no finished ceiling, suspend fixtures from construction by approved brackets and chains. Suspend fixtures in Mechanical

Equipment Room from the ceiling above. Fixtures shown on the drawings are to designate quantities only. Install fixtures, conduit and boxes after all ductwork, piping, etc., have been installed and locate as directed by Architect's representative in field.

E. Check the drawings, piping and duct work for clearances prior to ordering the fixtures shown in the schedule. Any conflicts with reference to the clearances shall be discussed with the Architect who shall decide what changes should be made.

F. Cooperate with all others on the job in determining exact location of all outlets, particularly those occurring in acoustical tile or on tile joints.

G. Support all recessed fixtures by frames and/or plaster rings as required, and mount as to be readily removable for inspection and maintenance. Make ceiling openings to closely and accurately match dimensions of recessed fixtures. Provide fixture supports to fit the particular ceiling support as shown on the architectural drawings.

H. Comply with all code requirements as to the operating temperature, radiation, surface heat insulation, spacing from outlets, accessibility, mounting etc., for all recessed installations.

I. Install all fixtures true and plumb and be free of light leaks, warps, dents or other irregularities.

J. Install all fixtures at the mounting heights shown or as directed. Pendant luminaries in the same room or area shall be installed at uniform heights above the finished floor.

K. Immediately prior to occupancy all luminaries must be clean and free from dirt, grease, finger marks and defects. Any parts broken prior to the turnover shall be replaced.

3.2 OCCUPANCY SENSORS

A. Contractor shall located and install occupancy sensor as per manufacturer’s written installation instructions.

B. Contractor shall set operating parameters, such as sensitivity and “off” timers at each location. The exact location and sensitivity setting shall be set so as to minimize false activations. Set initial time delay setting for 5 minutes. Coordinate final settings with owner, adjust timer as required by owner for each area.

C. Contractor shall test and record the operation of each occupancy sensor. Contractor shall verify the sensitivity setting to ensure that there are no false activation from movement outside the control area, and that timer function are operating within the set time frame.

3.3 TRAINING

A. The contractor shall provide training session(s) for Emergency Lighting System, and the operation and setting of the occupancy sensors. Training session shall be conducted by a qualified manufacturer’s representative. Training shall be scheduled with the owner at the owner’s convenience. Training shall be s be scheduled separately from unit start-up.

END OF SECTION 26 50 00