San Francisco International Airport

A&E Standards

Electrical – Generators, Distribution Equipment, and Transfer Switches

Division 26 – Electrical

Version 3.1 | SEP Subgroup 4.4 | March 2018

PREFACE

PURPOSE OF THIS DOCUMENT

The intent of this document is to disseminate SFO's expectations regarding the information presented to designers, engineers, general contractors and other industry specialists. The material provided in the following sections includes the minimal requirements, general information, design criteria, guide specifications and details for electrical generators, distribution equipment and transfer switches installed at SFO. While this document addresses major areas of concern to SFO, it is not an all-inclusive document.

HOW TO USE THIS DOCUMENT

This document should be used as a resource for the development of project specific design documents including drawings, details and specifications. It is the responsibility of the design, engineering and construction professionals to adhere to all codes and regulations related to the content presented.

SCOPE

This section contains the Standards and Criteria for Electrical Generators, Distribution Equipment and Transfer Switches. Any questions or concerns regarding the items or equals specified must be brought to the attention of the SFO Facilities Maintenance Department, in writing. All final decisions regarding products shall be made at the Owner's discretion. If Contractor presents items that are not specified or named equals, there may be a charge to the Contractor for evaluation of those products.

DRAWING REQUIREMENTS

A. All design disciplines including the architectural/engineering sub-consultants and the trade bid package subcontractors shall prepare documents using Revit in the current version utilized by the Airport in compliance with the Airport's Building Information Modeling (BIM) Requirements as described in Document 00 73 87: BIM Requirements, unless waived by the Chief Development Officer.

B. When Revit models may not be applicable, (for example, tasks with underground infrastructure beyond a building footprint), Civil 3D may be used to model utilities and applicable infrastructure if approved by the Chief Development Officer.

C. Refer to technical specifications for As-Built requirements.

D. Documents and plans submitted to SFO shall be searchable using PDFs with live text. This includes, but is not limited to, text and symbols. The document shall also provide the capability to turn layers on and off. Any project using legacy documents which may be composed image files shall be converted to live text via Optical Character Recognition (OCR).

Version	Publish Date	Revisions	Reviewed By
3.1	March 2018 *The March 2018 version was uploaded to SFOConstruction.com in November 2018.*	BIM language updated	Josephine Pofsky, N. King
3.0	December 2017	Combined edits; formatting	SFO Electrical Engineering; Greg McCarthy; N. King
2.0	February 2017		SFO Electrical Engineering
1.0	June 2015	---	SFO Electrical Engineering

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SECTION 26 08 01 – COMMISSIONING OF PHOTOVOLTAIC SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System specific commissioning for Photovoltaic Systems

B. Related Sections:
   1. General Commissioning Requirements
   2. Division 26

1.2 DESCRIPTION OF WORK – Refer to General Commissioning Requirements.

1.3 SUBMITTALS – Refer to General Commissioning Requirements

PART 2 – PRODUCTS

A. Not Included

PART 3 – EXECUTION

3.1 COMMISSIONING PROCESS AND PROCEDURES – Refer to General Commissioning Requirements

3.2 SYSTEM READINESS DOCUMENTATION

A. The Contractor shall review and complete all System Readiness documentation in accordance with General Commissioning Requirements and this section.

B. The Contractor shall provide a System Readiness Plan which shall include the following:

   1. System Readiness Checklists – provided by the Commissioning Authority (CxA) to be compiled and completed by the Contractor.

   2. Start-up and testing procedures and data forms for all equipment and systems within the commissioning scope of work, in accordance with the Contract Documents.

C. A sample System Readiness Checklist is provided at the end of this section. The final checklists will be drafted by the CxA after equipment submittals have been accepted.

D. The Contractor shall submit the System Readiness Plan with blank forms for CxA review.

E. A separate checklist shall be submitted and subsequently completed for each system and item of equipment within the commissioning scope of work as specified.

F. The System Readiness Checklists available in Appendix C for reference, do not represent all of the Contract Document requirements for the associated equipment. Completion of the items on the checklists do not release the contractor from requirements specified elsewhere.

G. The contractor shall submit the System Readiness Manual, the completed version of the System Readiness Plan, prior to Functional Performance Testing. When it is necessary to begin functional testing on a system (or systems) before the readiness of other systems can be documented, it may be acceptable to provide preliminary submittals of the System Readiness Manual for which checklists and forms have been completed only for the system(s) that are ready for testing.

H. The Contractor's Commissioning Coordinator (CC) shall verify completion of all documentation, sign the System Readiness Checklists and return the System Readiness Manual to the CxA as an indication of final completion of all installation criteria as specified in the Contract Documents.

3.3 TAB REVIEW

A. TAB review does not apply to the commissioned systems within this Division.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. The Functional Performance Test (FPT) procedures shall be developed, performed and demonstrated in accordance with all requirements.

B. At a minimum, the contractors and equipment suppliers listed in the FPT Minimum Participants Table in this Section 26 08 01 shall be required to participate in developing, performing and demonstrating the indicated FPTs.

C. A sample FPT is provided at the end of this section. The final FPTs will be drafted by the CxA after equipment submittals have been accepted.

D. The CC shall, with the CxA's input, coordinate the subcontractors in developing, performing and demonstrating the FPTs.

E. Functional testing shall consist of the following four phases:

1. Component testing:

a. Component testing applies to all control input and output (I/O) devices, including those provided by the equipment suppliers and those provided with the Building Management System (BMS), as applicable. Examples include but are not limited to: sensor assemblies, detectors, relays, switches, etc. Component testing also applies to relevant measuring devices, such as pyranometers.

b. Component testing consists of demonstrating field I/O calibration and operation including but not limited to:

1) Accuracy of sensors is within the design temperature range as specified.

2) Alarmed points report correctly to the operator work station, as applicable.

3) Accuracy and settings of binary switches and alarms are as specified within the design temperature range.

4) Fail safe operation of components and controllers is as specified for loss of control signal, electric power and/or network communications.

5) All components, values and alarms are correctly mapped to the operator interface station, as applicable.

2. System Testing – Operational Verification:

a. After functional testing of the system components has been successfully completed, each sequence of operation and control system function shall be functionally tested, including those provided by the equipment suppliers and those provided with the BMS, as applicable.

3. System Testing – Integrated System Verification:

a. After operational testing has successfully demonstrated that each system functions in accordance with the Contract Documents, functional testing shall occur to verify that the interaction between the systems is as required. Each interactive function shall be functionally tested, including those provided by the equipment suppliers and those provided with the BMS, as applicable.

4. System Testing – Real Time Performance Analysis (Trend Logging):

a. After operational testing has been successfully completed, real time performance testing shall be performed as applicable. Trend data shall be logged for the intervals and periods specified in the FPT procedures. Unless otherwise specified in the FPTs, test periods shall include occupied, unoccupied, weekend and holiday schedules.

b. Analysis of real-time performance data shall demonstrate that that the systems operate in accordance with the acceptance criteria specified in the FPT procedures. The Contractor shall verify that such data demonstrates acceptable results before submitting for CxA review. If acceptable results are not demonstrated, re-testing, trouble-shooting and corrective actions shall be performed to provide resolution. Provisions for retesting, including BACK-CHARGING as specified in Section 01 91 13, shall apply to trend analysis.

3.5 SEASONAL FUNCTIONAL PERFORMANCE TESTING

A. Seasonal functional testing does not apply to the commissioned systems within this Division.

3.6 FPT DEMONSTRATION SAMPLING

A. FPT demonstration sampling does not apply to the commissioned systems within this Division.

3.7 FPT MINIMUM PARTICIPANTS TABLE

A. At a minimum, the Commissioning Coordinator and the Electrical Contractor's Representative shall participate in the functional testing process and in demonstrating successful FPTs to the CxA.

3.8 SAMPLE SYSTEM READINESS CHECKLIST

A. Sample checklists are included in Appendix C to provide the contractor with a representation of the level of rigor required.

END OF SECTION 26 08 01

SECTION 26 31 10 – PHOTOVOLTAIC ELECTRIC GENERATING SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: Fully operational, photovoltaic, electric generating system.

B. Refer to architectural drawings for proposed roof area for photovoltaic.

C. Selected installer shall provide SFO with financial payback analysis of proposed system and assist with utility, federal and state incentive applications.

1.2 DEFINITIONS

A. Array: A mechanically-integrated assembly of modules and panels, together with support structure and foundation, tracking, thermal control, and other components, if used, to form a DC power-producing unit.

B. Azimuth angle: For a surface such as a sloped roof, project a line that extends perpendicular from the roof onto a horizontal plane. The angular deviation of this projection from the local meridian (north-south line) constitutes the surface azimuth angle. Due south is zero azimuth, west of south is assigned as positive, and east of south is assigned as negative.

C. Insolation: Sunlight, direct and/or diffuse (not to be confused with insulation). The integrated intensity of sunlight reaching a given area, usually expressed in watts per square meter per day. This measurement may be used to express the average amount of solar energy falling on different regions of the country.

D. Magnetic declination: The difference between true north (the axis around which the earth rotates) and magnetic north (the direction the needle of a compass will point).

E. Module: A number of solar cells connected together electrically and sealed inside a weatherproof package with a clear face. Sometimes called a "solar panel."

F. Panel: A designation for a number of PV modules assembled in a single mechanical frame.

G. Photovoltaic: Pertaining to the direct conversion of light into electricity.

H. PTC (PVUSA Test Conditions): Test conditions applied to PV modules intended to represent wattage during operation. Irradiance of 1000 W/10 sq. ft., 68 degrees F ambient temperature, 1 meter/second wind speed, and an air mass of 1.5.

I. String: A number of modules or panels interconnected electrically in series to produce the operating voltage required by the load.

J. STC (Standard Test Conditions): Test conditions applied to PV modules. Irradiance of 1000 W/10 sq. ft., temperature of 68 degrees F.

K. Tilt Angle: The angle of inclination of a solar panel measured form the horizontal plane.

L. Utility-Interactive Inverter: An inverter that can function only when electrically connected to the utility grid, and uses the prevailing line-voltage frequency on the utility line as a control parameter to ensure that the photovoltaic array's DC output is converted to AC power and fully synchronized with the utility power.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Contractor is responsible for providing the PV system, including attachment to structural system and necessary modifications to meet specified requirements and maintain visual design concepts.

2. Contract Drawings are diagrammatic and are intended to establish basic dimension of units, sight lines, and profiles of units.

3. Provide details for attachment, fastening, penetrations, and electrical connections.

4. Provide concealed fastening wherever possible.

5. Provide weather-tight penetrations of building envelope for structural and electrical connections.

6. Attachment considerations shall take into account site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening, or fracturing connection between PV system and building envelope components.

7. Comply with roof system manufacturer's warranty design criteria when penetrating roof system.

B. Performance Requirements:

1. PV system shall be designed to maximize kWh AC of energy production per year, utilizing multi-crystal panels that supply not less than 13 watts per square foot of panel area.

2. AC kWh energy production shall take into consideration system losses, including but not limited to wire losses, fault protection losses, inverter efficiency, and system component degradation over life expectancy of system.

3. Method and results of PV system performance estimate shall be shared with the Architect and design team and submitted as part of bid.

4. AC kWh energy production estimate shall report quantities of physical area required for PV modules and PV system size in kW AC Power Rating.

5. Standard photovoltaic modules shall produce no less than 80% of minimum rated power during first 20 years of service.

C. Interface with Building Systems

1. PV system AC connection point shall be Coordinated with the building load.

D. Financial Incentives, Rebates, and Tax Credit Eligibility Requirements for PV Systems:

1. Identify potential incentives, rebates, and tax incentives.
2. Provide PV System including design and installation that complies with eligibility requirements for PV system owner to receive incentives, rebates, and tax credits from sources such as federal, state, and electric utility services providers.

1.4 SUBMITTALS

A. Product Data:

1. Submit product data for photovoltaic system components.
    a. Include information for factory finishes, hardware, glass treatment, sealants, grounding, accessories, and other required components.

B. Shop Drawings:

1. Submit shop drawings covering fabrication, installation, and finish of specified systems.
    a. Fully dimensioned plans and elevations with detail coordination keys.
    b. Electrical and structural penetration details of weather-tight building envelope.
    c. Locations and types of exposed fasteners and joints.
    d. Wiring diagrams.
    e. Rough-in requirements.

C. Samples:

1. Provide samples of Photovoltaic module for approval. Approved samples may be used in final installation.
2. Provide on-site mockup of Photovoltaic module installation for approval. Locate on-site mock-up within project construction site. On-site mock up shall use mounting method and hardware intended for actual photovoltaic module installation.

D. Submit the following Informational Submittals:

1. LEED Submittal: See Section on LEED Certification Requirements for the following:
    a. MRc4 Recycled Content
    b. MRc5 Regional Materials
    c. EQc4.1 Low Emitting Materials, Adhesives & Sealants
2. Estimated Design Data:
    a. Provide assumptions used to obtain the required 30,500 kWh, which equates to 21 KW PV Array. This energy production shall include limitations due to: environmental loss factors, local weather data, and electrical losses.
    b. Estimated monthly and yearly AC kWh energy production.

3. Test Reports: Written results obtained from manufacturer or independent third party certification of testing specified as part of System Requirements and Source and Field Quality Control articles.

4. Certifications specified in Quality Assurance article.

5. Qualification Data:

    a. Contractor's and manufacturer's qualifications verifying minimum 5 years of commercial experience.

    b. Include list of 5 completed projects having similar scope of Work identified by name, location, date, reference names, and phone numbers.

6. Manufacturer's Instructions:

    a. Manufacturer's printed installation instructions.

    b. Indicate by transmittal that copies of instructions and recommendations have been distributed to installer.

7. Contractor's Field Reports: Written results and findings of Contractor's field services specified as part of Field Quality Control.

E. Closeout Submittals

1. Project Record Documents:

    a. Record actual locations of grounding systems and penetration of building envelope.

2. Operation and Maintenance Data: Submit manufacturer's printed and electronic, recommended operation and maintenance data.

3. Warranty: Submit specified product warranty in accordance with Division 01 sections pertaining to Warranty.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility: To ensure quality of appearance and performance, obtain equipment for systems from single photovoltaic system installer or from manufacturers approved by photovoltaic system installer.

B. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum 5 years documented experience.

C. Installer Qualifications: Certified in writing by equipment manufacturers as qualified for installation of specified systems. Must have NABCEP certification (North American Board of Certified Energy Practitioners), 5 years' design and installation of commercial experience, and proper licensing. Provide contractor's license number from Authority Having Jurisdiction where project is located.

D. Regulatory Requirements:

1. Provide system meeting requirements of National Electric Code (NEC), edition adopted by local jurisdiction, containing information on photovoltaic systems such as grounding, conductor, over-current protection, disconnect, and labeling requirements.

2. Provide system meeting requirements of federal, state, and local building codes.

3. Provide Photovoltaic modules compliant with requirements of UL-1703 - Standard for Flat Plate Photovoltaic Modules and Panels.

E. Certifications: Submit system component manufacturer's certification that products furnished for Project meet or exceed specified requirements.

1.6 PRE-INSTALLATION CONFERENCE

A. Conduct pre-installation conference with SFO, Design Team and Contractor.

B. Review requirements of Contract Documents and submittals.

C. Review anchor and weather-tight installation requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces as necessary to prevent damage.

B. Do not use adhesive papers or sprayed coatings that become firmly bonded when exposed to sun.

C. Do not leave coating residue on any surfaces.

D. Replace damaged units.

1.8 PROJECT CONDITIONS

A. Existing Conditions: Ensure existing conditions are stable, solid, and ready to accept new construction.

1.9 WARRANTY

A. Furnish Standard PV modules and panel components providing manufacturer's limited Warranty of 10 years minimum.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Products:
1. Suntech
2. Kyocera Solar Inc
3. First Solar
4. SunPower
5. Or approved equal

B. Inverter Manufacturers:

1. Advanced Energy
2. SatCon
3. SMA America

4. Xantrex
5. Substitution: refer to Division 01 sections
6. Or approved equal

2.2 REQUIRED EQUIPMENT

A. PV modules:

1. Shall be new, undamaged, fully warranted without defect.

2. Listed to UL 1703.

B. DC to AC Inverter:

1. Sized to provide maximum power point tracking for voltage and current range expected from photovoltaic array for temperatures and solar insolation conditions expected for Project conditions.

2. Capable of adjusting to "sun splash" from all possible combinations of cloud fringe effects without interruption of electrical production.

3. Listed to UL 1741.

C. Mounting System:

1. Non-penetrating Roof Mounting System:

a. Non-penetrating using weight (ballast) or adhesives or combination thereof to withstand wind and seismic loading.

b. System does not typically require structural attachment to building structure.

c. Ballasted system is intended for flat roof applications, the roof slope for this building is max Yz" per foot.

d. Ballasted roof mount systems shall utilize framed PV modules or frameless PV module laminates.

e. Ground metal framed PV modules in conformance with electrical codes.

D. AC Disconnect Switch:

1. Coordinate with local electric utility service provider requirements.

2. Provide switch to disconnect ungrounded AC conductors.

3. Lockable, gang operated type, clearly indicating open and closed positions.

4. Easily visually inspected to determine that switch is in open or closed position and clearly labeled in compliance with NEC and local electric utility service provider requirements.

E. Dedicated kWh Meter: Install in readily accessible, indoor, location between DC to AC inverter to meter power produced by photovoltaic system. Refer to local electric utility service provider requirements.

2.3 ACCESSORIES

A. Provide Accessories for complete operating system, including:

1. Data Display (including software and hardware).

2. Weather Station.

3. DC Disconnect.

2.4 FINISHES

A. Furnish PV module frames finished with manufacturer's standard colors on finishes. Submittal shall include options on color of anodized aluminum finish, if any.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify items provided by other Sections of work are properly sized and located.

B. Examine supporting members to ensure surfaces are at proper elevation and are free from dirt or other deleterious matter.

3.2 INSTALLATION

A. Locate PV array as shown on Drawings and approved shop drawings.

B. Install photovoltaic system in accordance with NEC, manufacturer's printed instructions, electric utility service provider requirements, and approved shop drawings.

C. Install PV modules and DC to AC inverters with sufficient clearance to allow for proper ventilation and cooling.

D. Comply with manufacturer's clearance recommendations.

E. Preferred installation requires operational PV modules in location and manner to ensure maximum unobstructed, direct sun exposure.

F. Provide suitable means to secure attachments to mounting surfaces and structures.

G. Anchors, fasteners and braces shall be structurally stressed not more than 50% of allowable stress when maximum loads are applied.

H. Allow for expansion and contraction due to thermal changes and structural movement without detriment to appearance or performance.

I. Installer shall verify that site, mounting surface substrate, supports and other site and work conditions are adequate and proper for installation.

3.3 FIELD QUALITY CONTROL

A. Site Tests: Perform site tests as required.

B. Manufacturer's Field Services: Provide field services to equipment as required.

3.4 ADJUSTING

A. Test and adjust operating functions in accordance with manufacturer's instructions to ensure smooth operation.

3.5 CLEANING

A. Clean surfaces in compliance with manufacturer's recommendations; remove excess mastic, mastic smears, foreign materials, and other unsightly marks.

B. Clean metal surfaces exercising care to avoid damage.

C. Clean energy generating surfaces of the PV module to ensure no obstructions block sunlight.

3.6 COMMISSIONING

A. Commissioning:

1. To be provided by Contractor/ Installer.
2. Prior to commissioning ensure PV system has passed and received final inspection certificate from authorities having jurisdiction and local utility.
3. Provide training to designated Owners representative.
4. Ensure the installation has been performed in accordance with NEC and other local codes. Following NEC articles refer to PV systems:
    a. Article 690, Solar Photovoltaic Systems.
    b. Article 230: Service Equipment - Disconnecting Means.
    c. Article 240: Overcurrent Protection.
    d. Article 250: Grounding.
    e. Article 300: Wiring Methods.
    f. Article 310: Conductors for General Wiring.
    g. Provide suitable tools and equipment for commissioning.
    h. Utilize System Commissioning Check sheet / Log sheet.
    i. Provide commissioning certificate to Owner.

3.7 PROTECTION

A. Protect finished work as required.

END OF SECTION 26 31 10

SECTION 26 32 00 – PACKAGED GENERATOR ASSEMBLY

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this section.

1.2 SECTION INCLUDES

A. Packaged engine generator system

B. Exhaust silencer and fittings

C. Fuel fittings and base fuel tank

D. Stationary radiator airflow load bank

E. Controls

F. Battery and charger

G. Weatherproof, acoustic housing

1.3 RELATED SECTIONS

A. Division 22 sections pertaining to Vibration and Seismic Controls for Plumbing Piping and Equipment

B. Division 23 sections pertaining to HVAC Insulation

C. Division 23 sections pertaining to Hydronic Piping: Installation of Exhaust Silencer and Piping

D. Division 26 sections pertaining to Switches and Circuit Breakers

E. Section 26 36 23 – Automatic Transfer Switches

1.4 REFERENCES

A. ANSI/NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

B. ANSI/NEMA MG-1 – Motors and Generators

C. ANSI/NFPA 70 – National Electrical Code

D. ANSI/NFPA 110 – Emergency and Standby Power Systems

E. ANSI/NEMA AB-1 – Molded Case Circuit Breakers

1.5 SYSTEM DESCRIPTION

A. Engine generator system to provide source of emergency and standby power.

B. System Capacity: System capacity will be based on load plus 25% for growth.

C. Responsibility: Supply and coordination of this equipment and ATS (Section 26 36 23 – Automatic Transfer Switches) shall be the responsibility of a single company which shall assure that all components work correctly together.

D. General Function: System shall include but not be limited to: engine generator set and automatic transfer switches for furnishing emergency and standby power for the facility. The transfer switches in normal position connect loads to the utility bus. Upon utility power failure, transfer switches shall signal the engine to automatically start. Upon reaching rated voltage and frequency within 10 seconds maximum the transfer switches shall automatically transfer the load to the generator. Upon return of utility power, automatic re-transfer of electrical load shall occur. After load re- transfers an adjustable timer shall permit engine-generator to cool down before shut off. The engine generator set shall be designed per NFPA 110 for single step loading capability with pick up time less than 10 seconds.

E. Generator set shall comply with the emission regulations of the Bay Area Air Quality District, including Best Acceptable Control Technology (BACT). Supplier of the equipment shall obtain operating permit for the generator set.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01 sections pertaining to Submittal Procedures.

B. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.

C. Submit product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, fuel tank, radiator, and remote annunciator.

D. Submit manufacturer's installation instructions under provisions of Division 01 sections pertaining to Submittal Procedures.

1.7 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 01 sections pertaining to Project Record Documents.

B. Accurately record location of engine generator and mechanical and electrical connections.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Division 01 sections pertaining to Closeout Procedures.

B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in packaged engine generator system with minimum three years documented experience.

B. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 100 miles of project site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01 sections pertaining to Product Requirements.

B. Store and protect products under provisions of Division 01 sections pertaining to Product Requirements.

C. Accept packaged engine generator set and accessories on site in crates and verify damage.

D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.11 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Division 01 sections pertaining to Closeout Procedures.

B. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal tool box.

C. Provide two additional sets of each fuel, oil, and air filter element required for the engine generator system.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Onan
B. Caterpillar
C. Kohler
D. Cummins

2.2 ENGINE

A. Type: Water-cooled inline or V-type, four stroke cycle, compression ignition Diesel internal combustion engine.

B. Rating: Sufficient to operate at ten% overload for one hour at specified elevation and ambient limits.

C. Fuel System: Appropriate for use of No. 2 fuel oil.

D. Engine Speed: 1800 rpm.

E. Governor: Isochronous type to maintain engine speed within 0.25%, steady state, and five%, no load to full load, with recovery to steady state within two seconds following sudden load changes. Equip governor with means for manual operation, and speed droop and load limit adjustment.

F. Safety Devices:

1. Engine shutdown on:

a. Low lubricating oil pressure.
b. High water temperature
c. Over speed
d. Engine over crank

2. Preliminary alarms on:

a. Low lubricating oil level
b. High water temperature
c. Low water temperature
d. Low water level

3. Limits as selected by manufacturer.

G. Engine Starting: DC starting system with positive engagement, two starter motors with voltage in accordance with manufacturer's instruction. Include remote starting control circuit, with 'MANUAL-OFF-REMOTE' selector switch on engine-generator control panel.

H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.

I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator Air Flow Restriction: 0.5 inches of water maximum.

J. Engine Accessories: Primary fuel strainer, secondary fuel filter, lube oil filter, intake air filter, lube oil cooler, engine driven, gear-type, positive displacement fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, lube oil temperature gauge, and lube oil pressure gauge on engine-generator.

K. Mounting: Mount on structural steel base.

2.3 GENERATOR

A. Generator: ANSI/NEMA MG-1; three-phase, four pole, re-connectible brushless synchronous generator with brushless exciter.

B. Rating based on design load plus growth

C. Insulation: ANSI/NEMA MG-1, Class F.

D. Temperature Rise: 130 degrees C continuous.

E. Voltage Regulation: Include volts per Hertz exciter regulator to match engine and generator characteristics, with voltage regulation ±1/4% during steady state conditions and ±2% from no load to full load. Limit transient voltage dip to 25% with recovery time of 1.2 seconds to +2% of rated voltage and steady state within 5 seconds upon application of full load. Include manual controls to adjust voltage drop ±5% voltage level, and voltage gain.

2.4 STATIONARY RADIATOR AIRFLOW COOLED LOAD BANK

A. The engine generator unit shall be equipped with a radiator mounted or ground mounted, radiator airflow cooled resistive load bank. The load bank shall be designed for automatic control, shall be rated for 100% load and shall be UL listed.

B. Power source to load bank is 480V 3-phase, 3wire plus ground.

C. Load Bank Rating based on design load plus growth.

D. Load elements:

1. Load elements shall be UL listed, labeled or recognized, totally enclosed, sealed with an electrically grounded outer sheath such that the element cannot be electrically short-circuited by external foreign objects and personnel are protected against accidental electrical shock. Elements shall be individually replaceable. Open wire type elements in which the electrically live conductors are exposed and which can be short circuited to each other or to ground by foreign objects or by the breakage of an element or an element support shall not be permitted.

2. Load element short circuit protection: Branch circuit fuses, per each 20KW load branch circuit. Fuses shall be 200,000 A.I.C. current limiting type.

E. Load Control: One magnetic contactor per each fused branch circuit.

F. Load bank power wiring shall be 150 ºC insulated.

G. Main Terminals: Barrier type power terminal block with compression type terminal to accept stranded building wire. Provide chassis ground stud with compression type terminal.

H. Control wiring shall be 105 ºC insulated.

I. Control power shall be derived internally from the main load bus. Control and protective circuits shall operate at 120V via control power transformer or line-neutral circuit and shall be fused.

J. System Protection: The load bank shall include a comprehensive protection system to protect against overheating. The system shall function to disconnect the load elements from the power source and activate an alarm upon sensing a loss of cooling airflow, or an exhaust air temperature greater than 300 degree F.

K. Automatic Load Bank Controller

L. The load bank is to be equipped with an automatic controller, which will be activated when the load bank mode control selector switch is placed in the “automatic” position.

M. In automatic mode, the load bank is to be on-line and continuously operative whenever the power source runs. The load bank shall provide a component of the total power source load and shall be automatically variable in response to dynamic total load demands upon the power source.

N. The automatic controller shall include control logic, solid-state sensors and time delays which shall act to apply/remove load bank component in multiple steps in response to dynamic output of the power source.

O. The automatic controller shall function to maintain total load upon the power source within a preset bandwidth by adding load bank load component as external load component as external load component drops and removing load bank component as external load rises

P. The automatic controller shall sense load (amperes – or – kilowatts).

Q. Full manual control of the load bank shall be restored when the mode selector switch is placed in the "manual" position.

R. The automatic controller shall include a solid-state load sensor with level and time delay adjustment and output contacts for each load step. A current transformer for external installation shall be provided.

2.5 VIBRATION ISOLATORS

A. The engine generator unit shall be equipped with spring type vibration isolators providing built in vertical limit stops and seismic restraint in all directions in accordance with UBC Seismic Zone 4 requirements. Provide seismic calculations signed by a California State Registered Professional Engineer verifying the integrity of the isolator restraint and the anchor.

2.6 OUTPUT CIRCUIT BREAKER(S)

A. Provide a fully 100% rated, unit mounted, output circuit breaker(s) as an integral part of engine generator set completely wired to enable single point connection by other. See drawings for breaker rating(s). Provide extra-large junction box at motor for cable connections.

2.7 ACCESSORIES

A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel resilient exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions.

B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 170 ampere- hours minimum capacity. Match battery voltage to starting system. Include necessary cables and clamps.

C. Battery Tray: Plastic coated metal or wooden tray treated for electrolyte resistance, constructed to contain spillage of electrolyte.

D. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.

E. Engine-Generator Controls:

1. Output voltage adjustment
2. Indicator lamps
3. Engine start/stop selector switch
4. Engine running time meter
5. Governor and voltage regulator
6. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
7. Remote Alarm Contacts: Pre-wire SPDT contacts to terminal strip for remote alarm functions required by ANSI/NFPA 99.
8. Oil pressure gauge
9. Water temperature gauge

F. Remote Engine Annunciator Panel: ANSI/NFPA 110; include engine run and low fuel indicator lights and remote start/stop switch; flush mounted panel with color painted finish.

G. Vibration Isolators: Each engine generator set shall be mounted on steel spring units sized to carry the set, with separate seismic restraints and 1-inch static depression.

H. Provide remote emergency stop in separate enclosure. Coordinate location in field with Owner's engineer.

I. Provide leak detection and monitoring for all fuel lines and base fuel tank. Provide double containment for all fuel lines and base fuel tank.

2.8 TEST AND INSPECTIONS

A. The generating system shall be tested in the factory in accordance with the codes and standards specified in paragraph 2.03. The generating unit shall be field tested for a period of two hours at full load unity P.F. and 1.0 PF and checked for safety features in the presence of Owner's Engineer. Full load shall be applied 0.8 power factor from a cold start.

B. Shop Tests: Prior to shipment, engine-generator unit shall be tested under load (reactive) to demonstrate its conformance with the specification requirements. The Owner reserves the right to be present at these tests. Supplier shall furnish to the Owner, in triplicate, a certification that the tests have been performed and that the unit does comply with specifications. Test logs and other pertinent data shall be forwarded. Repeated stops and starts shall be made to demonstrate response to the remote signal. The over speed device shall be test demonstrated three times. The high water temperature safety device shall be caused to operate with the unit under load. The low oil pressure device operation shall be simulated by a temporary jumper wire. There shall be repeated demonstrations of the unit's ability to accept full load suddenly applied. During these demonstrations there shall be recording made of output voltage and frequency and these shall become a part of the test report. A battery-starting test shall be performed, consisting of 5 cranking cycles of 10 seconds each. The shop test shall also include the following:

1. The engine-generator shall be electrically load tested for 4 hours. During the 4=hour test the following shall be performed:

2. Operate the engine-generator set 100% full load for 4 hours. During the first (1st) hour of the 100% load test, the machine shall be subjected to three conditions of no load – full load, voltage and frequency shall be monitored and recorded on the test data report.

C. A certified test report shall be issued confirming the results of this testing.

2.9 SPARE PARTS

A. One (1) complete set of filters (fuel, lube oil and air).

B. Provide complete list of replaceable parts with price list.

C. Provide one (1) standard tool set used for maintenance and changing of hoses, filters and belts.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work and field dimensions are as shown on Drawings.

B. Verify that required utilities are available in proper locations and ready for use.

C. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Division 01 sections pertaining to Contractor's Quality Control Program.

B. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.

C. During test, record the following at 20-minute intervals:

1. Kilowatts
2. Amperes
3. Voltage
4. Coolant temperature
5. Room temperature
6. Frequency
7. Oil pressure

D. Test alarm and shutdown circuits by simulating conditions.

E. Verify that engine generator system, in conjunction with the automatic transfer switches picks up the highest priority emergency loads within 10 seconds of the loss of utility power.

3.4 MANUFACTURER'S FIELD SERVICES

A. Prepare, start, test, and adjust systems under requirements of Commissioning Agent.

3.5 ADJUSTING

A. Adjust generator output voltage and engine speed.

B. Adjust timing so that highest priority loads are picked up within 10 seconds of power outage.

3.6 CLEANING

A. Clean work under provisions of Division 01 sections pertaining to Construction Waste Management.

B. Clean engine and generator surfaces. Replace oil and fuel filters according to manufacturer recommendations.

3.7 DEMONSTRATION AND INSTRUCTION

A. Provide systems demonstration under provisions of Division 01 sections pertaining to Closeout Procedures.

B. Describe loads connected to emergency system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

D. Provide four hours instruction to Owner's personnel on operation, maintenance and adjustment of equipment.

END OF SECTION 26 32 00

SECTION 26 32 13 – ENGINE GENERATORS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for standby power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Remote-mounting control and monitoring.
4. Outdoor enclosure.

B. Related Sections include the following:

1. Section 26 36 00 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 SUBMITTALS

A. General

1. Include generator permitting requirements and responsibilities for submission to proper authorities.

B. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for design vibration isolation bases.

3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.

4. Wiring Diagrams: Power, signal, and control wiring.

D. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 sections pertaining to "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For testing agency.

F. Source quality-control test reports.

1. Certified summary of prototype-unit test report.

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.

4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

5. Report of sound generation.

6. Report of exhaust emissions showing compliance with applicable regulations.

7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

G. Field quality-control test reports.

H. Warranty: Special warranty specified in this Section.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in the specification section entitled "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASME B15.1.

D. Comply with NFPA 37.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

H. Comply with UL 2200.

I. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 ºC.

2. Relative Humidity: 0 to 95%.

3. Altitude: Sea level to 1000 feet.

B. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:

1. High salt-dust content in the air due to sea-spray evaporation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in the Specifications Section entitled “Roof Accessories.”

1.7 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Caterpillar; Engine Div.
2. Onan/Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3% of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20% variation for 50% step- load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5% of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5% variation for 50% step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5% total and 3% for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50%. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250% of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
7. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90% of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.

G. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

H. Governor: Mechanical.

I. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine- generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50% ethylene-glycol-based antifreeze and 50% water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110% load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

a. Rating: 50-psig maximum working pressure with coolant at 180 ºF, and non-collapsible under vacuum.

b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

J. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.

2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

K. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

L. Starting System: 12-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

3. Cranking Cycle: As required by NFPA 110 for system level specified.

4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 ºC regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.

7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 ºC to plus 60 ºC to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10%.

d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.

2. Capacity: Fuel for eight hours' continuous operation at 100% rated power output.

3. Vandal-resistant fill cap.

4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode- selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.

12. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 sections pertaining to "Electrical Power Monitoring and Control."

G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Over-crank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.
6. Engine high-temperature shutdown.
7. Lube-oil, low-pressure shutdown.
8. Over speed shutdown.
9. Remote emergency-stop shutdown.
10. Engine high-temperature pre-alarm.
11. Lube-oil, low-pressure pre-alarm.
12. Fuel tank, low-fuel level.
13. Low coolant level.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush- mounting type to suit mounting conditions indicated.

I. Remote Emergency Stop Switch: Flush, wall mounted, unless otherwise indicated, and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100% rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.

2. Trip Rating: Matched to generator rating.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110% of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.

2. Under single or three-phase fault conditions, regulates generator to 300% of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.

4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground- fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125% of rating, and heat during operation at 110% of rated capacity.

F. Enclosure: Drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5% adjustment of output-voltage operating band.

2.8 Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

A. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

B. Sub-transient Reactance: 12%, maximum.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:

1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.

2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.

3. Space Heater: Thermostatically controlled and sized to prevent condensation.

4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.

5. Hinged Doors: With padlocking provisions.

6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.

7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.

8. Muffler Location: Within and external to enclosure.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110% of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

D. Convenience Outlets: Factory-wired GFCI. Arrange for external electrical connection.

2.10 MOTORS

A. General requirements for motors are specified in Division 23 sections pertaining to "Common Motor Requirements for HVAC Equipment."

B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Electrical Specifications.

2.11 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80% of compressed height of the spring at rated load.

3. Minimum Additional Travel: 50% of required deflection at rated load.

4. Lateral Stiffness: More than 80% of rated vertical stiffness.

5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.

2.12 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.13 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems shall be in accordance with the applicable requirements of SFFD Administrative Bulletin2.07 "Permit Application Checklist for Diesel Generators, Diesel Fuel Pumps, and Fuel Tanks Serving Generator and Fire Pumps."

E. Ground equipment according to Division 26 sections pertaining to "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 sections pertaining to "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to the Specification Sections entitled "Identification for HVAC Piping and Equipment" and "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float- charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100% step-load increases and decreases, and verify that performance is as specified.

9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25% and at 100% of rated linear load. Verify that harmonic content is within specified limits.

10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

M. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 sections pertaining to "Demonstration and Training."

END OF SECTION 26 32 13

SECTION 26 32 37 – DISTRIBUTION EQUIPMENT 60/400 HZ

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Main Switchboard - Furnish and install the Service Entrance switchboard(s) as herein specified and shown on the associated electrical drawings.

B. Distribution Switchboard - Furnish and install the Distribution Switchboard(s) as herein specified and shown on the associated electrical drawings

1.2 REFERENCES

A. The switchboard(s) and over-current protection devices referenced herein are designed and manufactured according to the following appropriate specifications.

1. ANSI/NFPA 70 - National Electrical Code (NEC).
2. ANSI/IEEE C12.16 - Solid State Electricity Metering.
3. ANSI C57.13 - Instrument Transformers.
4. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
5. NEMA PB 2 - Dead front Distribution Switchboards, File E8681
6. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Dead front Switchboards Rated 600 Volts or Less.
7. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
8. UL 50 - Cabinets and Boxes.
9. UL 489 - Molded Case Circuit Breakers. I. UL 891 - Dead-Front Switchboards.
10. UL 943 - Ground Fault Circuit Interrupters.
11. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.

1.3 SUBMITTALS

A. Shop Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; one-line diagrams; equipment schedule; and switchboard instrument details.

1.4 QUALIFICATIONS

A. Furnish products listed by Underwriters Laboratories Incorporated and in accordance with standards listed in Article 1.03 - References.

B. The manufacturing facility shall be registered by Underwriters Laboratories Inc. to the International Organization for Standardization ISO 9002 Series Standards for quality.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.

B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.

C. Inspect and report concealed damage to carrier within their required time period.

D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.7 MAINTENANCE MATERIALS

A. Provide 4 sets of installation and maintenance instructions with each switchboard. Instructions are to be easily identified and affixed within the incoming or main section of the line-up.

1.8 WARRANTY

A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or 18 months from date of purchase.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Square D Company.

B. Siemens

C. Substitutions must be submitted in writing to the Engineer with supporting documentation demonstrating that the alternate manufacturer conforms to all aspects of the specifications herein. Approval shall be at the discretion of the Engineer.

2.2 SWITCHBOARD – GENERAL

A. Short Circuit Current Rating: Switchboards shall be rated with a minimum short circuit current rating of 42kA rms symmetrical amperes at 600 VAC maximum.

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

C. Enclosure: Type 1 - General Purpose.

1. Sections shall be aligned front and rear.

2. Removable steel base channels (1.5 inch floor sills) shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.

3. The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be a medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment.

4. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.

5. Top and bottom conduit areas shall be clearly indicated on shop drawings.

D. Bus Composition: Shall be plated copper. Plating shall be applied continuously to all bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown in the plans. For 4-wire systems, the neutral shall be of equivalent ampacity as the phase bus bar. Tapered bus is not acceptable. Full provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.

E. Ground Bus: Sized per NFPA70 and UL 891 Tables 25.1 and 25.2 and shall extend the entire length of the switchboard. Provisions for the addition of future sections shall be provided.

2.3 SWITCHBOARD - INCOMING MAIN SECTION DEVICES

A. Main circuit breaker Group mounted through 1200A

1. Main Circuit breaker shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. 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.

3. Circuit breaker equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker of different frame sizes shall be capable of being mounted across from each other.

4. Line-side circuit breaker connections are to be jaw type.

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

6. Thermal magnetic molded case circuit breaker through 1200A]

a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.

b. Circuit protective devices shall be Square D molded case circuit breaker(s).

c. Circuit breaker(s) shall be standard interrupting Ampere ratings shall be as shown on the drawings.

2.4 SWITCHBOARD – DISTRIBUTION SECTION DEVICES

A. Group mounted circuit breakers through 1200A

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. 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.

3. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other.

4. Line-side circuit breaker connections are to be jaw type.

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

6. Electronic trip molded case full function 100% rated circuit breakers through1200A.

a. All electronic circuit breakers shall have the following time/current response adjustments: as directed by the Engineer. Each adjustment shall have discrete settings (fully adjustable) 0and shall be independent of all other adjustments.

b. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as directed by the Engineer.

c. Local visual trip indication for overload, short circuit and ground fault trip occurrences.

d. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

e. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.

f. Circuit breaker shall be provided with Zone selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as directed by the Engineer

g. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

h. Circuit breakers shall be tested and factory calibrated for 400 hertz applications.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine area to receive switchboard to provide adequate clearance for switchboard installation.

B. Start work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install switchboard in accordance with manufacturer's written guidelines, the NEC, and local codes.

3.3 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure, using a Megger, the insulation resistance of each bus section phase-to- phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.

C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Physically test key interlock systems to check for proper functionality. E. Test ground fault systems by operating push-to-test button.

3.4 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement per manufacturer's specifications.

B. Tighten bolted bus connections in accordance with manufacturer's instructions. C. Adjust circuit breaker trip and time delay settings to values as instructed by The Engineer.

END OF SECTION 26 32 37

SECTION 26 33 53 – STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
2. Surge suppression.
3. Input harmonics reduction.
4. Rectifier-charger.
5. Inverter.
6. Static bypass transfer switch.
7. Ni Cad Battery and battery disconnect device.
8. External maintenance bypass/isolation switch.
9. Output isolation transformer.
10. Remote UPS monitoring provisions.(Modbus)
11. Battery monitoring.
12. Remote monitoring.
13. Emergency Power Off trip provision

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. LCD: Liquid-crystal display.

C. LED: Light-emitting diode.

D. PC: Personal computer.

E. THD: Total harmonic distortion.

F. UPS: Uninterruptible power supply.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include data on features, components, ratings, and performance.

B. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels and battery arrangement.

2. Engineer of Record to confirm that equipment specified will fit in available space in conformance with NEC.

3. Wiring Diagrams: For power, signal, and control wiring.

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For UPS equipment, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: For each product, from manufacturer.

D. Factory Test Reports: Comply with specified requirements.

E. Field quality-control reports.

F. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

G. Warranties: Sample of special warranties.

H. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals.

I. Short circuit withstand ratings: Minimum 42kA Short Circuit Withstand Rating

1.5 QUALITY ASSURANCE

A. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies,

NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on site testing.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. UL Compliance: Listed and labeled under UL 1778 by an NRTL.

E. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.6 WARRANTY

A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for Ni Cad Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 ºF:

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	6 cycles
30 minutes	30 minutes	1.67	20 cycles
15 minutes	45 seconds	1.67	120 cycles

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: Two years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.

2. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.

3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.

4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-

charger then supplies power to the load through the inverter and simultaneously recharges the battery.

5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.

6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.

7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.

8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.

9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.

2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the 3 conditions in subparagraphs below without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.

2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.

3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.

1. Ambient Temperature for Electronic Components: 32 to 104 °F.

2. Ambient Temperature for Battery: 41 to 95 °F.

3. Relative Humidity: 0 to 95%, noncondensing.

4. Altitude: Sea level to 4000 feet.

2.2 PERFORMANCE REQUIREMENTS

A. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100% nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10% from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5% from nominal frequency.
4. THD of input voltage is 15% or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5% of the fundamental value.
5. Must be sized at 40-45% capacity.

B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80% power factor, duration of supply is 30 minutes.

C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15% from nominal voltage.

D. Overall UPS Efficiency: Equal to or greater than 90% at 100% load, 90% at 75% load, and 90% at 50% load.

E. Maximum Acoustical Noise: 55 dBA, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 3 feet from nearest surface of component enclosure.

F. Maximum Energizing Inrush Current: Eight times the full-load current.

G. Maximum AC Output-Voltage Regulation for Loads up to 50% Unbalanced: Plus or minus 2% over the full range of battery voltage.

H. Output Frequency: 60 Hz, plus or minus 0.5% over the full range of input voltage, load, and battery voltage.

I. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5%, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.

J. Maximum Harmonic Content of Output-Voltage Waveform: 5% rms total and 3.5 % rms for any single harmonic, for 100% rated nonlinear load current with a load crest factor of 3.0.

K. Minimum Overload Capacity of UPS at Rated Voltage: 125% of rated full load for 10 minutes, and 150% for 30 seconds in all operating modes.

L. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2% of that value within 100 ms:

1. 50%: Plus or minus 5%.

2. 100%: Plus or minus 5%.

3. Loss of AC Input Power: Plus or minus 1%.

4. Restoration of AC Input Power: Plus or minus 1%.

M. Input Power Factor: A minimum of 0.80 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.

N. EMI Emissions: Comply with FCC Rules and Regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide or comparable product by one of the following:
1. Eaton Corporation; Powerware Division.
2. Galaxy 3500, 5000 and VM; Schneider Electric/APC .
3. Mitsubishi Electric Automation, Inc.
4. Or Approved Equal

B. UPS entering end-of-life in less than 15 years is unacceptable.

A. UPS entering end-of-life in less than 15 years is unacceptable.

B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance

E. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B.

2. Additional Surge Protection: Protect internal UPS components from low-frequency, high- energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180% voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.

F. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

G. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future 25% increase in UPS capacity.

H. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

I. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

J. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95% of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5% of rated current, peak to peak.

C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.5 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output.

B. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.6 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.7 BATTERY

A. Description: Ni Cad batteries, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.

1. Arrange for draw out removal of battery assembly from cabinet for testing and inspecting. Batteries should be: Hot swappable and expandable with multiple run-times and an Integrated Battery Management System.

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

1. C&D Technologies, Inc.; Standby Power Division.
2. Eaton Corporation; Powerware Division.
3. EnerSys.
4. Panasonic Corporation of North America; Panasonic Industrial Company.

B. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

C. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

D. If Ni Cad batteries cannot be an option, submit VRLA battery specifications for Airport approval.

2.8 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: Plain-language messages on a digital LCD or LED.

1. Quantitative indications shall include the following:

a. Input voltage, each phase, line to line.
b. Input current, each phase, line to line.
c. Bypass input voltage, each phase, line to line.
d. Bypass input frequency.
e. System output voltage, each phase, line to line.
f. System output current, each phase.
g. System output frequency.
h. DC bus voltage.
i. Battery current and direction (charge/discharge)
j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:

a. Normal operation.
b. Load-on bypass.
c. Load-on battery.
d. Inverter off.
e. Alarm condition.

3. Alarm indications shall include the following:

a. Bypass ac input overvoltage or under voltage.
b. Bypass ac input over frequency or under frequency.
c. Bypass ac input and inverter out of synchronization.
d. Bypass ac input wrong-phase rotation.

e. Bypass ac input single-phase condition.
f. Bypass ac input filter fuse blown.
g. Internal frequency standard in use.
h. Battery system alarm.
i. Control power failure.
j. Fan failure.
k. UPS overload.
l. Battery-charging control faulty.
m. Input overvoltage or under voltage.
n. Input transformer over temperature.
o. Input circuit breaker tripped.
p. Input wrong-phase rotation.
q. Input single-phase condition.
r. Approaching end of battery operation.
s. Battery under voltage shutdown.
t. Maximum battery voltage.
u. Inverter fuse blown.
v. Inverter transformer over temperature.
w. Inverter over temperature.
x. Static bypass transfer switch over temperature.
y. Inverter power supply fault.
z. Inverter transistors out of saturation.
aa. Identification of faulty inverter section/leg.
bb. Inverter output overvoltage or under voltage.
cc. UPS overload shutdown.
dd. Inverter current sensor fault.
ee. Inverter output contactor open.
ff. Inverter current limit.
gg. Low battery
hh. Defective battery detected
ii. Battery over-temperature

4. Controls shall include the following:

a. Inverter on-off.
b. UPS start/Startup Screen
c. Battery test.
d. Alarm silence/reset.
e. Output-voltage adjustment.
f. Fault Reset
g. System Settings (Time, Date, Passwords, etc.)

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.
3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).
6. UPS Input failure
7. Common Fault
8. Low Battery

E. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.

2. Switch shall electrically isolate other UPS components to permit safe servicing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full UPS load current.

D. Mounting Provisions: Separate wall- or floor-mounted unit.

E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

2.10 OUTPUT DISTRIBUTION SECTION

A. Panel boards: Comply with division 26 sections pertaining to “Panel boards” except provide assembly integral to UPS cabinet.

2.11 MONITORING BY REMOTE COMPUTER

A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in “Controls and Indications” Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:

1. Standard connectors and network interface units or modems for data transmission via SNMP/Web-Base, Modbus, and RS-232 link at a minimum

2. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computers are not included in this Section.

2.12 BASIC BATTERY MONITORING

A. Manufacturers: Subject to compliance with requirements.

B. Manufacturers: Subject to compliance with requirements, provide or comparable product by one of the following:

1. Albercorp.

2. BTECH, Inc.
3. Eaton Corporation; Powerware Division.
4. Or approved equal.

C. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

D. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 ºC occurs within the compartment.

E. Annunciation of Alarms: At UPS control panel.

2.13 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.
6. Start-up, shutdown and transfers
7. Simulate utility power failure

B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.

2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.

3. List of instruments and equipment used in factory tests.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

3.3 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.4 IDENTIFICATION

A. Identify components and wiring according to Division 26 sections pertaining to "Identification for Electrical Systems."

1. Identify each battery cell individually.

3.5 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Comply with manufacturer's written instructions.

2. Inspect interiors of enclosures, including the following:

a. Integrity of mechanical and electrical connections.

b. Component type and labeling verification.

c. Ratings of installed components.

3. Test communication of status and alarms to remote monitoring equipment.

E. Seismic-restraint tests and inspections shall include the following:

1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices according to requirements in Division 26 sections pertaining to "Vibration and Seismic Controls for Electrical Systems."

F. The UPS system will be considered defective if it does not pass tests and inspections.

G. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

H. Prepare test and inspection reports.

3.7 PERFORMANCE TESTING

A. Engage the services of a qualified power quality specialist to perform tests and activities indicated for each UPS system.

B. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period.

1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.

2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2% for electrical parameters. Parameters to be monitored include the following:

1. Current: Each phase and neutral and grounding conductors.

2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.

3. Frequency transients.

4. Voltage swells and sags.

5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.

6. High-frequency noise.

7. Radio-frequency interference.

8. THD of the above currents and voltages.

9. Harmonic content of currents and voltages above.

D. Monitoring and Testing Procedures:

1. Exploratory Period: For the first two days of the first scheduled monitoring and testing period, make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.

2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.

    a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.

    b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.

    c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.

    d. Key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation and alarm information

    e. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.

E. Monitoring and Testing Assistance by Contractor:

1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.

2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.

3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.

4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.

5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

F. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

G. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in report:

1. Description of corrective actions performed during monitoring and survey work and their results.
2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
5. Recommendations for operating, adjusting, or revising UPS controls.
6. Recommendation for alterations to the UPS installation.
7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
8. Recommendations for power distribution system revisions.
9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

H. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION 26 33 53

SECTION 26 36 00 – TRANSFER SWITCHES

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Remote annunciation systems.

B. Related Requirements:

1. Specification Section entitled "Engine Generator" for automatic transfer switches for standby power.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Field quality-control reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA ICS 1. E. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Contactor Transfer Switches:

1. Manufacturers: Subject to compliance with requirements,

a. Emerson; ASCO Power Technologies, LP.
b. E Zenith Controls.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30% of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2% or better over an operating temperature range of minus 20 to plus 70 ºC.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric- motor-operated mechanism, mechanically and electrically interlocked in both directions.

1. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

F. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

G. Battery Charger: For generator starting batteries.

1. Float type rated 2 A.

2. Ammeter to display charging current.

3. Fused ac inputs and dc outputs.

H. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in the specification section entitled "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

D. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

E. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.

2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.

3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

a. Initiation occurs without active control of generator.

b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5% maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

F. Automatic Transfer-Switch Features:

1. Under voltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100% of nominal, and dropout voltage is adjustable from 75 to 98% of pickup value. Factory set for pickup at 90% and dropout at 85%.

2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100% of nominal. Factory set for pickup at 90%. Pickup frequency shall be adjustable from 90 to 100% of nominal. Factory set for pickup at 95%.

4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained under voltage of emergency source, provided normal supply has been restored.

5. Test Switch: Simulate normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

    b. Push-button programming control with digital display of settings.

    c. Integral battery operation of time switch when normal control power is not available.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Switch position.

3. Switch in test mode.

4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.

2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.

3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

4. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See the specification section entitled "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4" high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to the specification section entitled "Hangers and Supports for Electrical Systems."

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

D. Identify components according to the specification section entitled "Identification for Electrical Systems."

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to the specification section entitled "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to the specification section entitled "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspection with the assistance of a factory-authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

D. Coordinate tests with tests of generator and run them concurrently.

E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to the Division 01 specification section pertaining to Demonstration and Training.

END OF SECTION 26 36 00

SECTION 26 36 23 – AUTOMATIC TRANSFER SWITCHES & BYPASS-ISOLATION

PART 1 – GENERAL

1.1 SCOPE

A. Furnish and install automatic delayed transition transfer & bypass-isolation switch (DTTS/BPS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each DTTS/BPS system(s) shall consist of a delayed transition transfer switch and a two-way bypass/isolation switch. All DTTS/BPS and control modules shall be the product of the same manufacturer.

B. The DTTS/BPS shall transfer the load in delayed transition (break-before-make) mode. Transfer is accomplished with a user-defined interruption period in both directions adjustable from 1 second to 5 minutes in at least 15 increments.

1.2 CODES AND STANDARDS

A. The automatic delayed transition transfer & bypass-isolation switches and accessories shall conform to the requirements of:

1. UL 1008 - Standard for Transfer Switch Equipment
2. IEC 60947-6-1 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

1.3 MANUFACTURER

A. Automatic delayed transition transfer & bypass-isolation switches shall be equal to ASCO Series 7000.

B. Acceptable manufacturers:

1. Emerson; ASCO Power Technologies.
2. G.E., Zenith Control
3. Russelectric.

PART 2 – PRODUCTS

2.1 MECHANICALLY HELD TRANSFER SWITCH

A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a solenoid mechanism, momentarily energized. The transfer switch unit shall include both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at the same time. Main operators which include overcurrent disconnect devices OR do not include electrical and mechanical interlocks will not be accepted.

B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

C. 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.

D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

E. 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 rated 800 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

F. 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.

G. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

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 inter-wiring 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 customer 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:

EN 55011:1991	Emission standard - Group 1, Class A
EN 50082-2:1995	Generic immunity standard, from which:
EN 61000-4-2:1995	Electrostatic discharge (ESD) immunity
ENV 50140:1993	Radiated Electro-Magnetic field immunity
EN 61000-4-4:1995	Electrical fast transient (EFT) immunity
EN 61000-4-5:1995	Surge transient immunity
EN 61000-4-6:1996	Conducted Radio-Frequency field immunity

2.4 ENCLOSURE

A. The DTTS/BPS shall be furnished in a 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.

PART 3 – OPERATION

3.1 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 controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration shall be open transition. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.2 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 Under voltage	**Sources N&E,3φ**	**Dropout/Trip 70 to 98%**	**Pickup/Reset 85 to 100%**
Overvoltage Under frequency	N&E,3φ N&E	102 to 115% 85 to 98%	2% below trip 90 to 100%
Over frequency	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 and emergency to provide digital readout of voltage on all three phases, frequency and phase rotation.

3.3 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. An adjustable time delay of 0 to 6 seconds to override momentary emergency source outage to delay all retransfer signals during initial loading of engine generator set.

D. Two (2) 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.

E. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

F. 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.

G. The controller shall also include the following built-in time delays for Delayed Transition & Bypass-Isolation operation:

1. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

H. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

I. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port. The time delay value displayed on the LCD or remote device shall be the remaining time until the next event occurs.

3.4 ADDITIONAL FEATURES

A. A three (3) 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. Switches which require utilizing the keypad and display function or have no manual time delay bypass means are not acceptable.

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 DTTS is connected to the normal source and one contact closed, when the DTTS is connected to the emergency source.

D. LED indicating lights (16 mm industrial grade type 12) shall be provided; one to indicate when the DTTS is connected to the normal source (green) and one to indicate when the DTTS 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. The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:

G. 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.

H. Terminals shall be provided for a remote contact which opens to signal the DTTS 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.

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)
4. 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 2 times. This screen shall display a clear description of the active operating sequence and switch position. For example,

1. Normal

2. Failed
3. Load on
4. Normal
5. TD Normal to
6. Emerg 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 an optional 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. Date and time and reason for transfer normal to emergency.
    b. Date and time and reason for transfer emergency to normal.
    c. Date and time and reason for engine start.
    d. Date and time engine stopped.
    e. Date and time emergency source available.
    f. Date and time emergency source not available.
2. Statistical Data
    a. Total number of transfers.
    b. Total number of transfers due to source failure.
3. Total number of days controller is energized.
4. Total number of hours both normal and emergency sources are available.

Q. Communications Module - A full duplex RS485 interface shall be installed in the DTTS 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 72A.

PART 4 – ADDITIONAL REQUIREMENTS

4.1 WITHSTAND AND CLOSING RATINGS

A. The DTTS/BPS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the DTTS/BPS terminals with the type of overcurrent protection shown on the plans.

B. The DTTS/BPS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle ratings. DTTS/BPSs 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.

4.2 TESTS AND CERTIFICATION

A. The complete DTTS/BPS 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 DTTS/BPS 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.

4.3 SERVICE REPRESENTATION

A. The DTTS/BPS 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.

4.4 POWER MANAGER

A. Furnish Power Managers at locations shown to monitor all functions specified below.

B. The Power Managers shall be listed to UL 3111-1, CSA, CE Mark, and industrially rated for an operating temperature range of -20°C to 60°C.

C. The Power Manager shall be accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

D. The Power Manager shall be capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 – 32VDC.

E. Each Power Manager shall be capable of interfacing with an optional communications module to permit information to be sent to central location for display, analysis, and logging.

F. The Power Manager shall accept inputs from industry standard instrument trans-formers (120 VAC secondary PTs and 5A secondary CTs.) Direct phase voltage connections, 600 VAC and under, shall be possible without the use of PTs.

G. The Power Manager shall be applied in single, 3-phase, or three & four wire circuits. A fourth CT input shall be available to measure neutral or ground current.

H. All setup parameters required by the Power Manager shall be stored in non-volatile memory and retained in the event of a control power interruption.

I. The following metered readings shall be communicated by the Power Manager, via serial communication, when equipped with optional serial communications module:

1. Current, per phase RMS and neutral (if applicable)
2. Current Unbalance%
3. Voltage, phase-to-phase and phase-to-neutral
4. Voltage Unbalance%
5. Real power (KW), per phase and 3-phase total
6. Apparent power (KVA), per phase and 3-phase total
7. Reactive power (KVAR), per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency
10. Accumulated Energy, (MWH, MVAH, and MVARH)

J. The following energy readings shall be communicated by the Power Manager:

1. Accumulated real energy KWH
2. Accumulated reactive energy KVAH
3. Accumulated apparent energy KVARH

NOTE: For real and reactive energy reported values, separate total for energy flow from each source shall be stored, including the arithmetic sum.

K. Power Manager Input/Output Options.

1. Power Managers shall be equipped with the following I/O:
    a. Provide 8 solid state status inputs.
    b. Provide 4 relay output contacts
2. The Power Manager shall flush mount to an enclosure. [The following section is optional and should be deleted if not used.]
3. The Power Managers shall be equipped with an optional continuous duty, long-life, 4 line x 20 character LCD backlit display to provide local access to the following metered quantities:
    a. Current, per phase RMS and neutral (if applicable)
    b. Current Unbalance %
    c. Voltage, phase-to-phase and phase-to-neutral
    d. Voltage Unbalance %
    e. Real power, per phase and 3-phase total

f. Apparent power, per phase and 3-phase total
g. Reactive power, per phase and 3-phase total
h. Power factor, 3-phase total & per phase
i. Frequency
j. Accumulated Energy, (MWH, MVAH, and MVARH)

4. Displaying each of the Power Manager quantities shall be accomplished through the use of menu scroll buttons.

5. For ease in operator viewing, the display shall remain on continuously, with no detrimental effect on the life of the Power Manager.

6. Setup for system requirements shall be allowed from the front of the Power Manager. Setup provisions shall include:

   a. CT rating; see submittal specification section
   b. PT rating (if applicable; 24000V maximum); see submittals
   c. System type (single; three phase; 3 and 4 wire)
   d. Communication parameters

7. Reset of the following electrical parameters shall also be allowed from the front of the Power Manager:

   a. Real energy (MWH), apparent energy (MVAH) and reactive energy (MVARH).

8. All reset and setup functions shall have a means for protection against unauthorized/accidental changes.

END OF SECTION 26 36 23

APPENDIX A – MASTER LIST OF MANUFACTURERS

This section provides the Master List of Manufacturers approved for Generators, Distribution Equipment and TransferSwitchesby SFO organized by section and subsection.

26 32 00 – Packaged Generator Assembly

1. Caterpillar
2. Cummins (Onan)
3. Kohler
4. Or approved equal.

26 32 13 – Engine Generators

1. Caterpillar Engine Div.
2. Cummins (Onan)
3. Or approved equal.

26 32 37 – Distribution Equipment 60/400 Hz

1. Square D Company
2. Siemens
3. Or approved equal.

26 33 53 – Static Uninterruptible Power Supply

UPS SYSTEMS

1. Eaton Corporation; Power Division.
2. Liebert Corporation; a Division of Emerson.
3. Galaxy 3500, 5000, and VM .
4. MGE UPS Systems.
5. Mitsubishi Electric Automation, Inc.
6. Toshiba Corporation; Industrial Systems.
7. Or approved equal.

BATTERY

1. C&D Technologies, Inc.; Standby Power Division
2. Eaton Corporation; Powerware Division
3. EnerSys
4. Panasonic Corporation of North America; Panasonic Industrial Company
5. Or approved equal.

BASIC BATTERY MONITORING

1. Albercorp.
2. BTECH, Inc.
3. Eaton Corporation; Powerware Division.
4. Or approved equal.

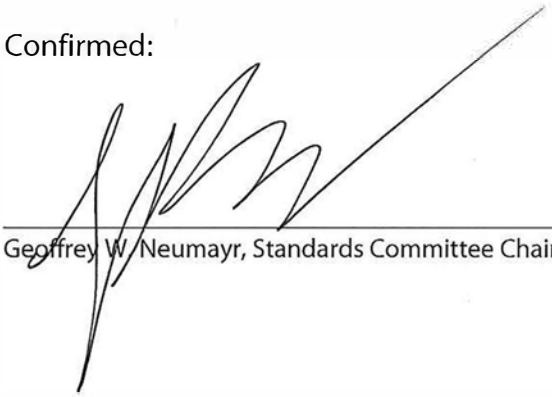
1. Contractor Transfer Switches
2. Emerson; ASCO Power Technologies, LP.
3. Generac Power Systems, Inc.
4. Or approved equal.

SFO San Francisco International Airport

Standards Adoption

The "Electrical – Generators, Distribution Equipment, and Transfer Switches" Version 3.1, March 2018 standards were adopted by the Standards Committee on April 5th, 2018, and are effective immediately.

Confirmed:



Geoffrey W. Neumayr, Standards Committee Chair