SECTION 16225 – ELECTRICAL POWER GENERATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.2 DESCRIPTION OF WORK

A. Furnish an emergency power generation and automatic transfer system to automatically sense the loss of utility power, start the generator set and transfer the critical load between the normal and backup power source. The system shall also sense the return of utility power and automatically restore the system to its normal operating state.

B. The following general systems and equipment shall be provided for the new building, as a minimum, but not necessarily limited to the following:

1. Emergency distribution system.
2. Hoisting, rigging, setting of all equipment.
3. Testing, cleaning and adjusting.
4. Shop drawings.
5. Automatic transfer switches.
6. Emergency generator, and exterior weatherproof sound attenuated housing.

1.3 RELATED WORK

A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 16010.

B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

C. For work related to, and to be coordinated with, the electrical work, but not included in this Section and required to be performed under other designated Sections, see the following:

1. Section 033000 – Concrete housekeeping pad
2. Division 15 - Fuel oil system

1.4 REFERENCES

A. The electrical power generation and transfer equipment covered by these specifications shall be designed, tested and assembled in strict accordance with the latest edition of all applicable standards including, but not limited to, the following:

1. National Electrical Code (NEC) 700, 701, 702
2. NEC 517
3. National Fire Protection Association (NFPA) 110
4. NFPA 101
5. NFPA 99
6. American National Standards Institute (ANSI)
7. Underwriters Laboratories (UL)
8. Institute of Electrical and Electronics Engineers (IEEE)

B. Emergency Generator

1. The emergency generator and all components shall be designed, manufactured and tested in accordance with the latest applicable standards as follows:

a. American Society of Mechanical Engineers (ASME)
b. EEC 89/392 Safety and Health
c. Electrical Generating Systems Association
d. Institute of Electrical and Electronic Engineers (IEEE)
e. National Electrical Code (NEC)
f. National Electrical Manufacturers Association (NEMA)
g. National Fire Protection Agency (NFPA)
h. Occupational Safety and Health Act (OSHA)

1.5 QUALITY ASSURANCE

A. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.

B. To ensure system compatibility, the automatic transfer switches, bypass isolation switches and emergency generators shall be furnished to the Electrical Subcontractor by the generator set manufacturer for single source responsibility.

C. The manufacturer shall have a local, authorized dealer who can provide factory trained servicemen, the required stock of replacement parts, technical assistance and warranty administration within a reasonable distance from the project.

1.6 WARRANTY

A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 16010 regarding guarantees and warranties for the work under this Contract.

B. In addition to the requirements above, the manufacturer of the generator set and automatic transfer switches shall provide a full five (5) year extended warranty from starting from the date of the accepted job site testing. The warranty shall include the following:

1. Repair parts
2. Labor
3. Travel expenses
4. Expendables including:
5. Lubricating oil
6. Filters
7. Antifreeze
8. Other service items made unusable by the defect.
9. In the event the generator and/or transfer switch require replacement, the warranty shall also cover:

    a. Removal of the defective unit, including hoisting and rigging.
    b. Installation of the new unit including hoisting and rigging.
    c. Temporary generator and/or transfer switch to maintain occupancy of the facility.
    d. All required electrical disconnections and connections to restore the system to its original condition.

C. Warranty Nameplate

1. A warranty nameplate, 6” x 8” shall be affixed to the generator set with the following data:

    a. Warranty period
    b. Start-up date
    c. Termination date
    d. Supplier name
    e. Supplier address
    f. 24 hour emergency telephone number
    g. Preventative maintenance to be performed by:

1.7 MAINTENANCE AND REPAIR CONTRACT

A. The generator set supplier shall offer, to the Owner, a maintenance and repair contract, which guarantees all support costs of the specified system. It shall include routine and 24 hour emergency access to a factory account manager to expedite emergency repairs.

B. The contract shall protect the user from parts and labor price increases and shall provide a refund of residual funds at any time of user dissatisfaction.

C. Optional payment schedules shall include:

1. Fixed rate throughout the life of the contract.
2. Graduated rate, which increases the low initial cost throughout the life of the contract.
3. Deferred rate which delays contract payment until expiration of the standard warranty.
4. Lump sum discounted payment.

1.8 SUBMITTALS

A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with the Shop Drawings, Product Data and Samples Section 013300 in the manner described therein, modified as noted hereinafter.

B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.

C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.

D. Shop drawings shall include, but shall not be limited to, the following:

1. Component List - A breakdown of all components and options including transfer switches.
2. Automatic transfer switches:

a. Descriptive literature
b. Ratings
c. Sequence of operation
d. Plan, elevation, side and front view arrangement drawings with overall dimensions and clearance requirements
e. Mounting and anchoring requirements
f. Conduit entrance locations
g. Equipment weights
h. Schematic diagrams
i. Wiring diagrams
j. Accessories list
k. UL Listings

3. Generator Set

a. Technical Data - Manufacturer produced generator set specification or data sheet identifying make and model of engine and generator, and including relevant component design and performance data.

b. Engine:

1) Type, aspiration, compression ratio, and combustion cycle
2) Bore, stroke, displacement, and number of cylinders
3) Engine lubricating oil capacity
4) Engine coolant capacity without radiator
5) Engine coolant capacity with radiator
6) Coolant pump external resistance (maximum)
7) Coolant pump flow at maximum resistance

c. Alternator:

1) Model
2) Frame
3) Insulation class
4) Number of leads
5) Weight, total
6) Weight, rotor
7) Air flow
8) Conduit entrance locations

d. At rated voltage:

1) Efficiency at 0.8 power factor for:

a) 50% load
b) 75% load
c) 100% load

2) Time constants; short circuit transient (T'D)
3) Time constants, armature short circuit (TA)
4) Reactance, subtransient - direct axis (X"D),
5) Reactance, transient - saturated (X'D)
6) Reactance, synchronous - direct axis (XD)
7) Reactance, negative sequence (X2)
8) Reactance, zero sequence (X0)
9) Fault current, 3 phase symmetrical
10) Decrement curve

e. Radiator:

1) Model
2) Type

3) Fan drive ratio
4) Coolant capacity, radiator
5) Coolant capacity, radiator and engine
6) Weight, dry
7) Weight, wet
8) Airflow
9) Static pressure

f. Generator set characteristics:

1) Power rating at 0.8 power factor
2) kVA rating
3) Fuel consumption at standard conditions for:

a) 50 % load
b) 75 % load
c) 100% load

4) Combustion air inlet flow rate
5) Exhaust gas, flow rate
6) Stack temperature
7) Exhaust system backpressure (maximum)
8) Heat rejection to:

a) Coolant
b) Aftercooler
c) Exhaust
d) Atmosphere from engine
e) Atmosphere from generator

9) Overall dimensions:

a) Length
b) Width
c) Height

10) Weight, dry
11) Weight, wet

g. Unit mounted circuit breaker.
h. Mounting and anchoring requirements to meet seismic zone requirements.
i. Performance - Based on SAE J1349 standard conditions of 100 kPa (29.61 in Hg) and 25C (77F); also at conditions of ISO 3046/1, DIN 6271 and BS 5514. Fuel rates are based on ISO 3046 and on fuel oil of 35 degrees API (16C or 60F) gravity, having a LHV of 42780 kJ/kg (18,390 Btu/lb.) when used at 29C-(85F) and weighing 838.9 g/l (7.001 lbs./U.S. gal).

j. Drawings - General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.

k. Wiring Diagrams - Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and switchgear showing interconnected points and logic diagrams for use by contractor and owner.

l. Specification or data sheets for auxiliary equipment, including:

1) Vibration isolators
2) Silencer
3) Day tank, with transfer pumps.
4) Enclosure
5) Battery charger
6) Batteries

4. Written statement of warranty.
5. Service - Location and description of supplier's parts and service facility including parts inventory and number of qualified generator set service personnel.
6. The following equipment rooms with all the electrical equipment laid out with dimensions, Code clearances, etc., indicated shall be submitted with the equipment shop drawings. Acceptance of these shop drawings shall be obtained prior to installation of feeder conduits:

a. All emergency electrical rooms and closets.
b. Emergency generators.
c. Automatic transfer switches/distribution switchgear.

Notes:

Equipment shop drawings will not be reviewed without the room/equipment layouts.

The Architect/Engineer reserve the right to rearrange equipment in electrical equipment rooms or spaces once final equipment dimensional information is known and prior to installation of the equipment. Install equipment in the final location selected by the Architect/Engineer at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 AUTOMATIC TRANSFER BYPASS/ISOLATION SWITCH

A. Manufacturers

1. Automatic transfer switches shall be dual operator automatic transfer switches as manufactured by Russelectric RMTD or equivalent product as manufactured by ASCo.

2. Combination automatic transfer bypass/isolation switches for life safety and critical branches shall be single operator automatic transfer switch as manufactured by Russelectric RTB or equivalent product as manufactured by ASCo.

B. Ratings

1. 480 Volt Class Automatic Transfer Switches shall have a close and withstand rating of 65,000 RMS Symmetrical Amperes at 480 volts AC. The transfer switch manufacturer may be required to supply higher ampacity rated automatic transfer switch than shown on the drawings in order to meet the minimum withstand rating required.
2. 480 Volt Class Automatic Transfer Switches shall have a close and withstand rating of 200,000 RMS Symmetrical Amperes at 480 volts AC with listed current limiting fuse.
3. As a condition of approval, the manufacturer of the automatic transfer switches shall verify that their switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with fully rated 3 cycle short circuit closing and withstand values as indicated above. Series ratings of automatic transfer switches will not be acceptable.

    a. During the 3 cycle closing and withstand tests, there shall be no contact welding or damage. The 3 cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contacts separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL 1008, and testing shall be certified by Underwriters' Laboratories, Inc.
    b. When conducting temperature rise tests to UL 1008, the manufacture shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

4. The microprocessor controller shall meet the following requirements:

    a. Storage conditions - 25 degrees C to 85 degrees C
    b. Operation conditions - 20 degrees C to 70 degrees C ambient
    c. Humidity 0 to 99% relative humidity, non-condensing
    d. Capable of withstanding infinite power interruptions
    e. Surge withstand per ANSI/IEEE C-37.90A-1978

C. Construction

1. The automatic transfer switch (ATS) and its associated bypass/isolation switch (BPS) shall be furnished as shown on the drawings. Voltage and continuous current ratings and number of poles shall be as shown.
2. Each automatic transfer switch shall have the number of poles as shown on the drawings. Where 4 pole switches are indicated, a true 4 pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.
3. The automatic transfer bypass/isolation switch shall be mounted in a NEMA 1 enclosure, unless otherwise indicated. Enclosures shall be fabricated from 12 gauge steel. The enclosure shall be sized to exceed minimum wire bending space required by UL 1008.
4. The transfer switch shall be equipped with an internal welded steel pocket, housing an operations and maintenance manual.

5. The automatic transfer bypass/isolation switch shall have top and bottom cable access.
6. The main contacts shall be capable of being replaced without removing the main power cables.
7. The main contacts shall be visible for inspection without any major disassembly of the transfer switch.
8. All bolted bus connections shall have Belleville compression type washers.
9. When a solid neutral is required, a fully rated bus bar with required AL-CU neutral lugs shall be provided.
10. Control components and wiring shall be front accessible. All control wires shall be multi-conductor 18 gauge, 600 volt SIS switchboard type with point to point harness. All control wire terminations shall be identified with tubular sleeve-type markers.
11. The switch shall be equipped with 90 degrees C rated copper/aluminum solderless mechanical compression type lugs. Lugs shall be sized to accommodate conductor sizes as indicated on the drawings.
12. The complete automatic transfer bypass/isolation switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.
13. The automatic transfer switch and bypass/isolation switch shall be bused together with silver plated copper bus to provide a complete pre-tested assembly. Aluminum bus, and/or cable interconnections are not acceptable. Construction shall be such that the Electrical Subcontractor needs to install only the power and control connections.
14. Bypass/isolation switches shall provide a safe and convenient means for manually bypassing and isolating the automatic transfer switch, regardless of the condition or position of the ATS, with the ability to be used as an emergency back-up system in the event the transfer switch should fail. In addition, the bypass/isolation switch shall be utilized to facilitate maintenance and repair of the automatic transfer switch.
15. The automatic transfer switch shall be completely isolated from the bypass/isolation switch by means of insulating barriers and separate access doors to positively prevent hazard to operating personnel while servicing the automatic transfer switch.

D. Bypass/Isolation Construction

1. All main contacts and operating linkages of the bypass/isolation section shall be identical to the ATS, except that the operation shall be manual.
2. The bypass/isolation switch shall have the same electrical ratings of ampacity, voltage, short circuit withstand, and temperature rise capability as the associated ATS. The main contacts of the bypass switch shall be mechanically locked in both the normal bypass and emergency bypass positions without the use of hooks, latches, magnets, or springs and shall be silver-tungsten alloy, protected by arcing contacts with magnetic blowouts on each pole. The switching mechanism shall provide “quick-break,” “quick-make” operation of the contacts.
3. The primary buswork of the draw-out automatic transfer switch shall be connected to the stationary bus stabs in the freestanding cubicle by silver plated, segmented, self-aligning, primary disconnect fingers to facilitate proper alignment between the removable draw-out when the ATS is withdrawn and shall be available for inspection without disturbing or de-energizing the main bus.

4. The secondary control disconnect contacts mounted on the ATS shall be self-aligning and shall plug into the stationary elements mounted on the freestanding cubicle. Separate, manual, secondary control disconnect plugs are not acceptable.
5. The isolating portion of the bypass/isolation shall allow the automatic transfer switch to be disconnected from all sources of power and control without opening the enclosure door. The transfer switch shall have a true draw-out configuration which does not require disconnection of any electrical or mechanical device by maintaining personnel. The automatic transfer switch shall be provided with rollers or casters to allow it to be removed from its enclosure simply by rolling it out. Positive mechanical interlocks shall be provided to insure that the bypass/isolation functions can be accomplished without the danger of a short circuit.
6. A fourth pole, switched neutral shall be provided if the associated automatic transfer switch is designed as 4 pole. Basic 4 pole, bypass/isolation switch construction shall be identical to the associated automatic transfer switch construction.
7. Necessary controls shall be provided to ensure that the "engine run" circuit remains closed when the switch is in the bypass-to-emergency position, even though the associated transfer switch is in the "normal" position or completely removed from the enclosure.

E. Automatic Transfer Switch

1. Single operator transfer switch(es) shall be double throw, actuated by a single electrical operator momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Total transfer time shall not exceed one half second. For transfer switches utilizing in-phase monitors, passive synchronization will not be acceptable.
2. Dual operator transfer switch(es) shall be double throw, actuated by two electric motor operators or electric solenoids momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Minimum transfer time shall be 400 milliseconds. Transfer between two energized sources shall have an adjustable time delay of 0 to 9,999 seconds, factory set at 3 seconds to allow for motor wind-down. Single operator transfer switches with passive in-phase monitors will not be acceptable.
3. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungsten alloy. Separate arcing contacts with magnetic blowouts shall be provided on all transfer switches. Interlocked, molded case circuit breakers or contactors are not acceptable.
4. The transfer switch shall be equipped with a safe, external manual operator, designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. The manual operator shall be safely operated from outside of the transfer switch enclosure while the enclosure door is closed.

F. Automatic Transfer Switch Controls

1. The transfer switch shall be equipped with a microprocessor based control system, to provide all the operational functions of the automatic transfer switch. The controller shall

have two asynchronous serial ports. The controller shall have a real time clock with Nicad battery back-up.

2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory I/O and communication circuits, with a watchdog/power fail circuit.
3. The controller shall use industry standard open architecture communication protocol for high speed serial communications via multi-drop connection to other controllers and to a master terminal with up to 4000 feet of cable, or further, with the addition of a communication repeater. The serial communication port shall be RS422/485 compatible.
4. The serial communication port shall allow interface to either the manufacturer's or the Owner's furnished remote supervisory control.
5. The controller shall have password protection required to limit access to qualified and authorized personnel.
6. The controller shall include a 20 character, LCD display, with a keypad, which allows access to the system.
7. The controller shall include three phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.
8. The controller shall be capable of storing the following records in memory for access either locally or remotely:

    a. Number of hours transfer switch is in the emergency position (total since record reset).
    b. Number of hours emergency power is available (total since record reset).
    c. Total transfer in either direction (total since record reset).
    d. Date, time, and description of the last four source failures.
    e. Date of the last exercise period.
    f. Date of record reset.

G. Sequence of Operation

1. When the voltage on any phase of the normal source drops below 80% or increases to 120%, or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-9,999 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant.
2. The transfer switch shall transfer to the emergency source when the generating plant has reached 90% of rated voltage and frequency on all phases.
3. After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-9,999 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source.
4. After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-9,999 seconds, factory set at 300 seconds.

H. Automatic Transfer Switch Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and over-voltage sensing to pickup at 120% and dropout out at 110% of rated voltage. Programmable under-frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases set at 20%, and phase sequence monitoring.
2. Programmable three phase sensing of the emergency source set to pickup at 90% and dropout at 80% of rated voltage and over-voltage sensing to pickup at 120% and dropout out at 110% of rated voltage. Programmable under-frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases set at 20%, and phase sequence monitoring.
3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9,999 seconds. Factory set at 3 seconds, if not otherwise specified.
4. For dual operator automatic transfer switches, time delay to control contact transition time on transfer to either source shall be provided. Programmable 0-9,999 seconds, factory set at 3 seconds.
5. Time delay on retransfer to normal, programmable 0-9,999 seconds, factory set at 300 seconds if not otherwise specified, with overrun to provide programmable 0-9,999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.
6. A maintained type load test switch shall be included to simulate a normal power failure.
7. A remote type load test switch shall be included to simulate a normal power failure, remote switch initiated.
8. A time delay bypass on retransfer to normal shall be included.
9. Contact, rated 10 amperes, 30 volts DC, to close on failure of normal source to initiate engine starting.
10. Contact, rated 10 amperes, 30 volts DC, to open on failure of normal source for customer functions.
11. Light emitting diodes shall be mounted on the microprocessor panel to indicate: switch is in normal position, switch is in emergency position and controller is running.
12. Provide selected transfer switches as indicated on one-line diagram with “LS” load shed, and “BT” block transfer contacts, for future paralleling.
13. Two auxiliary contacts rated 10 ampere, 120 volts AC (for switches 100 to 800 amps) 15 ampere, 120 volts AC (for switches 1,000 to 4,000 amps), shall be mounted on the main shaft, one closed on normal, the other closed on emergency. Both contacts will be wired to a terminal strip for ease of customer connections.
14. A three phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase to phase voltages for both the normal and emergency source.
15. A digital LCD frequency readout with 1% accuracy shall display frequency for both normal and emergency source.
16. An LCD readout shall display normal source and emergency source availability.
17. Include two (2) time delay contacts that open simultaneously 10 seconds (adjustable 0 - 10 seconds) prior to transfer in either direction when transferring between two live

sources. These contacts close after a time delay upon transfer. Programmable 0-9,999 seconds after transfer. This contact is for use by the elevator controller.

I. Field Wiring

1. The Electrical Subcontractor shall run control wiring between each transfer switch engine start circuit and the respective generator to be started.
2. The Electrical Subcontractor shall run control wiring between the transfer switch(es) serving the elevators and each elevator controller. Control wiring shall indicate when the transfer switch is in the emergency position for selective operation of elevators. Control wiring shall also be provided to indicate when the transfer switch will transfer between two live sources via accessory contacts indicated above to allow elevators to stop prior to transfer.
3. Control wiring indicated in paragraphs 1. and 2. above shall be installed in one (1) hour fire rated construction or shall be Pyrotenax System 1850 MI cable for its entire length.

J. Manufacturer

1. The combination transfer bypass/isolation switch manufacturer shall employ a nationwide factory-direct, field service organization, available on a 24 hour a day, 365 days a year, call basis.
2. The manufacture shall include an 800 telephone number, for field service contact, affixed to each enclosure.
3. The manufacturer shall maintain records of each transfer bypass/isolation switch, by serial number, for a minimum 20 years.

2.2 EMERGENCY GENERATORS

A. General

1. Furnish and install a new diesel engine driven generator set, with physical capacities and controls, as specified herein and shown on drawings. The engine generator set shall be mounted in a walk-in, sound attenuated, weatherproof enclosure.
2. The engine generator set shall be 1000 kW, 1250 kVA standby rated. The ratings shall be with water pump attached. All units shall be capable of picking up their rated capacity in one (1) step and provide a transition time, from instant failure of the normal power source to the emergency generator source, of ten (10) seconds or less. The rating shall conform with BS649:1958 and DIN "A" 6270 and each diesel generator shall be provided as specified herein.
3. The engine generator set shall be as manufactured by Caterpillar Model Number C32, Tier 2 or equivalent product as manufactured by Cummins/Onan.

Generator Rating (kW)		Generator Model	EPA Tier Capability	Radiator Air Flow	Combustion CFM
Standby Power	Prime Power				
100	90	D100	2	12,000	40

Generator Rating (kW)		Generator Model	EPA Tier Capability	Radiator Air Flow	Combustion CFM
Standby Power	Prime Power				
125	114	D125	3	11,000	50
150	135	D150	3	13,000	50
200	180	D200	3	21,000	90
250	225	C9	3	21,000	1,100
300	265	C9	3	21,000	1,100
350	320	C15	3	30,000	1,500
400	365	C15	3	30,000	1,700
450	410	C15	3	30,000	1,800
500	455	C15	3	34,000	1,800
550	500	C15	2	34,000	1,800
600	545	C18	2	33,000	2,000
650	575	C27	2	34,000	2,200
700	635	C27	2	34,000	2,300
750	675	C27	2	34,000	2,500
800	720	C27	2	34,000	2,700
900	820	C32	2	46,000	3,600
1,000	910	C32	2	46,000	3,800
1,250	1,135	3512C	2	87,000	5,300
1,500	1,360	3512C	2	87,000	5,300
1,750	1,600	3516C	2	107,000	7,400
2,000	1,820	3516C	2	107,000	7,400
2,250	2,000	3516C	2	115,000	8,100
2,500	2,250	3516C-HD	2	115,000	8,100

4. The engine generator set supplier shall submit documentation to prove that service and parts are available 24 hours/day, 7 days/week, 365 days/year. Service time, after receipt of notification of problem or failure, shall not exceed four (4) hours for response and arrival of technical service representative at the jobsite. Generator sets shall be furnished by the authorized distributors of the equipment who have assigned territory in the area in which the generator sets are to be installed. Equipment furnished by others not having a defined assigned territory will not be considered.

B. Engine

1. The engine shall operate satisfactorily on a commercial grade of No. 2 diesel fuel oil and shall not require a premium fuel such as kerosene. Ratings shall be as listed in the 2000 Diesel and Gas Turbine Worldwide Catalog. Engines with new or special ratings will not be considered.
2. The generator set shall be EPA Tier 2 Certified and in compliance with the State of Maine Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with the indicated EPA Tier emissions standards per ISO 8178 - D2 Emissions Cycle at specified ekW /bHP rating. Utilization of the

"Transition Program for Equipment Manufacturers " also know as “Flex Credits” to achieve indicated Tier certification will NOT be considered.

3. If after coolers are required, the only source of water shall be engine jacket water.
4. The diesel engine shall be of the vertical, 16-cylinder, 4-cycle, fuel injection diesel type, with moving parts housed. Two-cycle engines will be unacceptable and will not be considered. The maximum speed of the engine in the service anticipated shall not exceed 1,800 rpm. The fuel injection system for the engine shall be of the low pressure type. The cylinder liners of the engine shall be of the wet type and removable. The complete diesel engine generator unit shall be free from critical and torsional vibration within the operating speed range. The engine shall be furnished complete with the following accessories:

    a. Spin-on full flow and bypass type lubricating oil filters with drain extension.
    b. Oil bath type or dry type replaceable element type air cleaner for air intake system. Fuel oil cooler shall be provided and factory piped on the radiator by the engine supplier.
    c. Replaceable, spin-on dual element type filters and strainers, to be engine mounted in fuel line between supply tank and fuel pump.
    d. Two (2) Racor fuel strainer/water separator with drain.
    e. The engine speed shall be governed by Woodward Model EG3P electronic isochronous governor (for future parallel operation), to maintain governed speed at 0% control for rated frequency operation. The frequency at any constant load, including no load, shall remain within a steady state band width or ±0.25% of rated frequency (isochronous operation).
    f. Overspeed shutdown control for protection against overspeeding. Overspeed control shall be solid state type.
    g. The engine shall be furnished with a unit mounted radiator cooling system having sufficient capacity for cooling the engine when the diesel generator set is delivering full-rated load at an altitude of 500’-0”. Manufacturer shall supply factory test data to verify radiator cooling at full load with 110°F ambient measured 10'-0" behind generator set and with an external static pressure drop of 0.5” WC (in addition to the radiator core restriction).
    h. Radiator shall be supplied with radiator duct flange and pressure cap.
    i. Low coolant level warning contacts with audible and visual alarm shall be furnished in radiator expansion tanks.
    j. The engine cooling system shall be filled with a solution of 40% ethylene glycol and 60% distilled water.
    k. Water conditioner for treating cooling water (replaceable element type).
    l. Two (2) jacket water heater(s) 6,000 watt, 208 volt, single phase, with thermostatic control and oil pressure disconnect switch to maintain engine at constant temperature of 90°F to 120°F. Jacket water heaters shall be furnished with ball valve shut-offs at the inlet and outlet and factory wired relays to disconnect power during engine operation.
    m. The engine shall have a full guard system for all belts, pulleys, vibration dampers. The guard system shall meet the requirements of OSHA.
    n. Fuel oil cooler shall be installed on the radiator and piped by generator manufacturer to cool the hot fuel returning to the day tank. Fuel shall be cooled to below 65°C at all load levels up to its capacity.

o. Furnish and install exhaust manifold and turbo charger guards in accordance with OSHA requirements.

5. A recessed mounted remote alarm annunciator per NFPA 99 shall be included for installation by the Electrical Subcontractor in the building managers office. Annunciator shall be in compliance with NEC and shall include interface terminal block to match numerically and sequentially with generator mounted annunciator terminal block. Panel shall have stainless steel faceplate with engraved nameplates for audio and visual indication for the following:

   a. Generator running: Green (Visual only)
   b. Battery charger malfunction: Amber (Visual only)
   c. Battery charger switch in "off" position
   d. Low lubricating oil pressure
   e. Low water temperature
   f. High water temperature
   g. Low water level
   h. Low fuel supply: Amber
   i. Fuel tank rupture
   j. Overcrank (failed to start)
   k. Overspeed
   l. Ground fault indication
   m. Generator derangement
   n. Annunciator "Off": Red flashing (Visual only)
   o. Lamp test switch, momentary
   p. Alarm horn with On/Off switch

6. Engine generator set shall be supplied with a unit mounted control and engine gauge panel, mounted and wired. Combination engine/generator controls and indicator shall include:

   a. Control panel to have built-in diagnostic capability to annunciate loss for shutdown sensing control.
   b. Fuel pressure gauge and tachometer.
   c. AC voltmeter, true RMS, 0.5% accuracy, digital.
   d. DC voltmeter, digital.
   e. Water temperature gauge, digital.
   f. Oil pressure gauge, digital.
   g. AC ammeter, true RMS, 0.5% accuracy, digital.
   h. Combination voltmeter/ammeter phase selector switch.
   i. Frequency meter, 0.5% accuracy.
   j. Elapsed time meter.
   k. Three (3) Current transformers and potential transformers.
   l. Necessary fuses.
   m. Generator voltage regulator, solid state, ±1% accuracy.
   n. Voltage adjusting rheostat, ±10%.

o. Auto-start control consisting of:

1) Shutdowns and prewarn devices and corresponding indicating lights for:

a)	Ground Fault	Blue
b)	Low Fuel Supply	Amber
c)	Low Oil Pressure Prewarn	Amber
d)	Low Oil Pressure Shutdown	Red
e)	High Water Temperature Prewarn	Amber
f)	High Water Temperature Shutdown	Red
g)	Low Water Level Shutdown	Red
h)	Low Water Temperature	Amber
i)	Overspeed	Red
j)	Overcrank	Red
k)	Fuel Tank Rupture	Amber
l)	Battery Charger Malfunction	Amber
m)	Flashing Light for Selector Switch "Off"	Red
n)	Lamp Test Switch	Momentary

2) Alarm contacts for all shutdown and prewarns wired to terminal strip for remote annunciator panel.
3) Alarm contacts for all shutdown and prewarn wired to terminal strip for use by the Building Automation System. Also, provide a common alarm relay providing at least one set of normally closed dry contacts opening on any shutdown or prewarn condition.
4) Alarm contacts for all shutdown and prewarn wired to a terminal strip for use by the Owner.
5) Alarm contacts for the following indications, wired to terminal strip for fire alarm system annunciation:

a) Emergency generator "ON"
b) Emergency generator "start failure"
c) Emergency generator "common pre-alarm"
d) Emergency generator "common shutdown"

6) Mode selector switch - "Auto-Off/Reset Manual".
7) Control power fuse.
8) Sets of auxiliary contacts, NO/NC, rated 3 amperes at 120 volts AC.
9) Panel illuminating lights.
10) Remote start contacts.
11) Step oil protection

7. The engine manufacturer shall provide the necessary lube oil for the crankcase and antifreeze for the cooling system to provide protection to -20°F. Test kit shall be provided to determine sulfate or phosphate levels in the system. Oil and coolant drains with lockable valves shall also be provided.

C. Generator

1. The generator shall be 1000 kW, 1250 kVA standby rated, 3 phase, 4 wire, 277/480 volts, 60 Hz, 12 lead and 0.8 power factor.
2. The generator shall meet all requirements of NEMA MG-1, Part 22, dated June, 1978, in design, performance and factory test procedures. The regulator shall be factory wired and tested with the generator.
3. Cast iron end brackets and fabricated steel frames shall be used. The unit shall be fully guarded per NEMA MG-1-1.25. Bearings shall be of the shielded anti-friction type with provisions for adding and/or changing grease through grease pipes extended to the generator exterior. Minimum B-10 bearing life shall be 40,000 hours.
4. Each generator shall be of brushless construction using a full-wave, 3 phase rotating rectifier assembly with hermetically sealed, metallic type silicon diodes to supply the main field excitation. The rotating exciter shall be mounted outboard of the generator bearing to allow removal of all or any part of the exciter without disassembly of the generator. It shall be possible to check the rotating diodes without breaking any solder connection. A multi-plate solenium surge suppressor shall be connected across the rotating diode network to protect it against transient conditions. A permanent magnet (PMG) type generator shall be furnished.
5. The insulation system of both the rotor and stator shall be of NEMA Class F materials and shall be synthetic and non-hygroscopic. The stator winding shall be given five (5) dips and bakes of varnish, plus a final coating of epoxy for extra moisture and abrasion resistance. The rotor shall be layer wound with thermosetting epoxy between each layer, plus a final coating of epoxy for moisture and abrasion resistance.
6. The main rotating field shall consist of one (1) piece, 4 pole laminations. Dovetails, cross bolts, and other pole to shaft connection means will not be acceptable. The amortisseur winding and field pole coil supports shall be integrally die cast with the rotor laminations to form a single piece rotor core. Fabricated and welded or brazed amortisseur windings and coil supports will not be acceptable. The rotor core shall be shrunk fit and keyed to the shaft. The temperature rise of both the rotor and stator, as measured by the resistance method, shall be in accordance with NEMA MG-1-22.40 for Class F insulation systems, standby rating at 130°C rise over 40°C ambient.
7. The voltage regulation shall be ±1.0% from no-load to full load and 5% frequency variation. Regulator drift shall be less than 1% per 72°F (40°C) ambient temperature change. The voltage regulator shall be 3 phase sensing type, volts per hertz static type using non-aging, hermetically sealed, silicon controlled rectifiers, with radio interference suppression to normally acceptable commercial levels. The regulator printed circuit board shall be covered with a conformal coating to protect it from moisture. Regulator shall include under-frequency, over-voltage and overload protection. Regulator shall have a circuit which removes excitation when generator is overloaded for more than ten (10) seconds.
8. Voltage dip shall not exceed 20% upon application of emergency loads, at 0.8 power factor, with recovery to steady state band conditions within five (5) seconds as measured on a light beam recorder.
9. The wave form harmonic distortion shall not exceed 5% total RMS measured line-to-line at full rated load. The TIF factor shall not exceed 50.
10. Each generator shall be self-ventilated and shall have a one (1) piece, cast aluminum alloy, uni-directional internal fan for high volume, low noise air delivery.

11. All performance and temperature rise data submitted by the generator manufacturer shall be the result of the actual test of the same or duplicate generators. Temperature rise data shall be the result of full load, 0.8 power factor heat runs at the rated voltage and hertz. All performance testing shall be done in accordance with Mil. Std. 705 and/or IEEE Std. 115.
12. Each generator shall be furnished with an oversized wiring chamber with bus copper bars, mounted on the generator end of the unit. Lugs shall be suitable for the conductors installed in flexible liquidtight conduit with sufficient slack to compensate for generator deflection, and shall be mounted on bus bar assembly prior to shipment. Furnish, for installation in the wiring chamber in the field by the Electrical Subcontractor, zero (0) sequence ground fault current transformers for indication only, with auxiliary contacts for control panel and remote annunciation.

D. Circuit Breakers

1. Provide 100% rated insulated case circuit breaker(s) with mechanical compression set screw lugs for cable sizes as indicated on the drawings. Circuit breaker(s) shall be sized as indicated on the drawings and shall be unit mounted on generator.

E. Exhaust System

1. Critical grade exhaust silencer, fully the equal of Maxim Model M51, with condensate drains and of the proper size for use with the engine, shall be furnished. Flexible, full length stainless steel connector shall be furnished. The generator set manufacturer shall furnish a wye connector with all appropriate fittings, flanges, etc., as required.
2. Exhaust silencer shall be mounted and insulated within the enclosure and prepiped to the generator and exhaust stack. Provide Guy wired on stack.

F. Battery/Charger

1. Two (2) 12 volt heavy duty lead acid storage batteries for each starter shall be provided, connected for 24 volt output, having a capacity of 205 amperage hours at 20-hour rate; 1050 amperes, 1.5 minutes at 0°F; and 1250 amperes, 1.5 minutes at 32°F, complete with necessary cable and connectors, sized in accordance with manufacturer's recommendation. In no event shall less than Size 000 cable be used. A battery rack shall be provided. Battery heater pad shall be provided for 120 volt operation.
2. A float battery charger shall be provided for the units, for maintaining the batteries at full charge at all times. It shall be in a steel enclosure for wall mounting, and be fed from the enclosure panelboard at 120 volt, single-phase, 60 Hz and the DC output shall be wired to the batteries. The charger shall be capable of withstanding temperatures as low as 0°F. The charger shall be LaMarche Mfg. Co. Model A46-20-24V, to provide 20 amperes, 24 volt DC output with 120 volts, single-phase, 60 Hz, AC input.
3. The charger shall employ transistorized controlled magnetic amplifier circuits to provide continuous taper charging. The charge shall vary from 0.05 amperes on a low battery to a milliampere current on a fully charged battery. It shall maintain rated output voltage within ±1.0% from no-load to full-load with AC variations

of ±10%. It shall have float and equalize ranges, 0 to 24 hour equalizing charger timer, AC line compensation, automatic overload protection (current limiting), fused AC input and DC output, automatic DC regulation and automatic surge suppressors. Silicon rectifiers shall be used.

4. The charger shall have a DC ammeter and DC voltmeter. Low DC voltage, high DC voltage, alarm relays and AC power failure relay shall be included for remote annunciation.

G. Weatherproof Housing

1. The generator set shall be enclosed in a walk-in weatherproof enclosures as detailed on the drawings and constructed of aluminum throughout. The housing shall be designed to accommodate heavy snow loads and shall be equipped with motorized intake and exhaust louvers, pre-wired and pre-piped prior to shipment. Housing shall be Pritchard Brown #2130 and shall be constructed per IBC requirements.
2. The housing shall have the following approximate dimensions:

   a. Width: 12’ Minimum
   b. Length: 35’ Maximum
   c. Height: 14’ Maximum

3. Housing shall have hinged, lockable, keyed alike doors with stainless steel hardware. The doors shall be so arranged as to provide access to vital parts of the generator set for service. Oil pan well and oil drain extension shall be included. Coolant drain and oil drain shall be extended outside housing with lockable rustproof valves.
4. Housing shall be prepainted with manufacturers standard baked-on aluminum exterior finish or spray painted with custom color. Baked-on or spray paint color shall be as selected by the Architect at the time of submission. Submit paint chart of baked-on finishes with submittal. Interior shall be anodized aluminum.
5. Housing shall include sound attenuation with thickness and type of sound insulation and intake and exhaust baffles necessary to achieve a maximum sound pressure level of 60 dB at a distance of 100'-0” from the units, in any direction. There shall be no puretone. Walls and ceiling shall be lined with perforated aluminum liner.
6. Housing shall be equipped with enclosed and gasketed fluorescent fixtures with 0° ballasts, octron lamps and on/off switch, and two (2) duplex receptacles. The enclosure shall also have two (2) DC lighting fixtures with self-contained battery with 120 volt input from enclosure panel.
7. Housing shall be equipped with a minimum of two (2) electric unit heaters, prewired to the enclosure panelboard to maintain a minimum of 50°F with an exterior design temperature of 0°F.
8. Housing shall be completely wired prior to shipment including main circuit breakers and enclosure panelboard as indicated on the drawings. Lugs shall be provided for incoming feeders.
9. Enclosure panelboard shall be 100A, 3 phase, 4 wire, 208/120 volt with 100 ampere, 3 pole main circuit breaker and branch breakers, sized as required,

(minimum 20 ampere, single phase) for the following equipment including, but not limited to:

a. Jacket water heaters (2)
b. Battery pad heaters
c. Enclosure heaters (2)
d. Battery charger
e. Motorized dampers
f. Circuit for ATC (2)
g. 20 ampere, single pole spares (6)
h. Day tank fuel transfer pump

10. All lighting (including battery light) and receptacles within the enclosure shall be prewired to a separate junction box for field wiring to a life safety panelboard. Lighting circuit shall be independent of receptacle circuit.
11. The generator housing manufacturer shall supply a day tank mounted within enclosure. The day tank shall include the following:

a. 150 gallon, vented, pressure tested tank with double walled rupture basin, UL listed.
b. Transfer pump set to draw fuel from main tank. Coordinate pump lift requirements with Mechanical Contractor.
c. Sight glass.
d. Threaded connections, prepiped by the enclosure manufacturer, for:

1) Engine supply.
2) Engine return.
3) Vent.
4) Drain.

e. Floor mounting brackets.
f. Low fuel level alarm relay.
g. Rupture basin with "rupture" alarm relay.
h. Fuel tank shall be in complete compliance with Local Codes and Ordinances. Fuel tank shall be factory prepiped and wired within the enclosure.
i. UL listed venting arrangement, prepiped with vent caps prior to shipment.

12. The generator housing manufacturer shall commission the services of a registered Professional Engineer from the state of Maine to certify that the construction of the generator housing is in accordance with Seismic Zone Group IIB with effective peak ground acceleration of 0.10 Verify. The registered professional engineer shall stamp the enclosure shop drawings prior to submission, indicating compliance.

PART 3 - EXECUTION

3.1 COOPERATION AND WORK PROGRESS

A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.

B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor, shall be assumed by him without any additional cost to the Owner.

C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.

D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.

G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of

the Architect) on the project site prior to installation may be subject to rejection by the Architect.

H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.

I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

3.2 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
6. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co. Where reference to channel supports is made under "Lighting Fixtures" paragraph of this Section, the maximum length of span shall be 10'-0". If longer spans are required, the size and wall thickness of the steel channel support shall be as specifically approved by the Engineer.

B. Concrete Housekeeping Pads

1. Concrete pads shall be installed for all freestanding electrical distribution equipment, including:

    a. Emergency Generators
    b. Generator control switchgear
    c. Automatic transfer switches

2. The General Contractor shall provide the concrete work. Electrical Subcontractor shall supervise and coordinate concrete work to ensure that proper grounding cable, rods, conduit, etc., are located as detailed and as required. The electrical Subcontractor shall also ensure that the concrete is level to within manufacturers published tolerances.
3. All concrete housekeeping pads shall extend a minimum of 6" on each side from the equipment mounted on it. Mounting height of each overcurrent/disconnect device in the above equipment shall not exceed 6'-6" above finished floor. If overcurrent devices exceed 6'-6" above finished floor as a result of the housekeeping pad, the pad shall extend in front of the gear a minimum of 4'-0".

C. Electrical Distribution Equipment

1. The Electrical Subcontractor shall install all emergency electrical distribution equipment per the manufacturers recommendations and the Contract Drawings.
2. The installation of all equipment, including working space requirements, shall conform to all NEC and local codes.
3. All necessary hardware to secure the assembly in place shall be provided by the Electrical Subcontractor.
4. The Electrical Subcontractor shall ensure that no piping, ductwork or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to that of the electrical distribution equipment plus 6" on either side of panel.
5. Floor mounted assemblies shall be installed on concrete housekeeping pads and shall be provided with adequate lifting means. Floor mounted assemblies shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills. The Electrical Subcontractor shall ensure the floor is level to 1/8 inch per 3-foot distance in any direction.
6. All floor and wall mounted electrical equipment shall be installed such that the handle of the highest circuit breaker does not exceed 6'-6" above finished floor.
7. Electrical distribution equipment that is part of the emergency distribution system shall be located in spaces fully protected by an approved automatic fire suppression system or in spaces with a one (1) hour fire resistance rating.

8. The equipment shall be installed and checked in accordance with the manufacturer's recommendations prior to first energization. This shall include but not limited to:

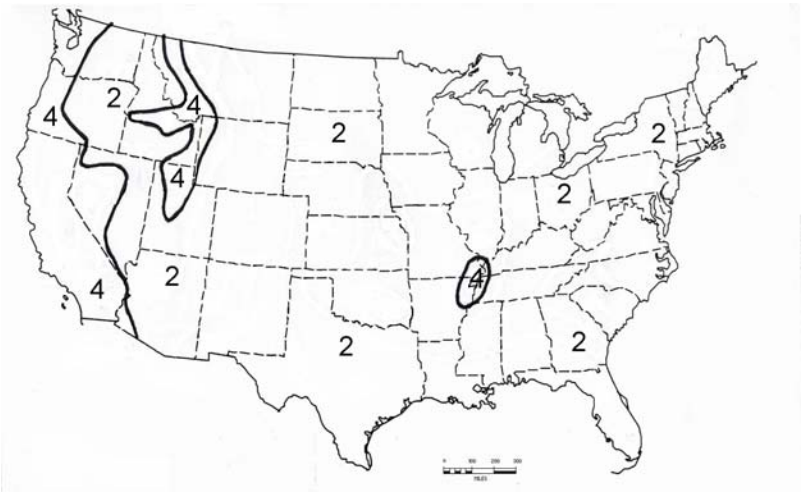
    a. Checking to ensure that the pad location is level to within .125 inches.
    b. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.

c. Assemble all shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.
d. Secure assemblies to foundation or floor channels.
e. Measure and record megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
f. Inspect and install all circuit breakers, components, etc. in their proper compartments.

9. Identification shall be provided for all electrical distribution equipment. The electrical system identification shall clearly describe the equipment connected. Method of identification shall be by laminated nameplate made of bakelite or similar material with engraved letters at least 1/4" high and securely attached to the equipment with galvanized screws. Adhesives or cements shall not be used. A list of nameplates shall be submitted to the Architect for approval prior to fabrication.
10. Control wiring shall be provided as required. Interface all local and remote control wiring and operational systems for each load.

D. Emergency Generator - Mounting and Vibration Isolation

1. The engine and generator shall be close-coupled and mounted on a structural steel base designed to maintain proper alignment of the unit.
2. The unit shall be certified by the manufacturer to be free from any critical torsional vibrations within a range of plus or minus 10% of synchronous speed.
3. Isolate the genset with combination steel-spring and elastomer isolators with restraint hardware, made of materials suited for the service.



4. The vibration isolators for the emergency generator set shall be suitable for and certified to meet all applicable seismic requirements of the latest accepted edition of the Maine State Building Code for seismic zone 2 application. Guidelines for the installation consistent with these requirements shall be provided by the emergency generator set manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, with a peak acceleration

and ZPA as required per the Code. The tests shall fully envelope the response spectrum for all equipment natural frequencies up to at least 35 Hz.

5. All connections to the genset, including exhaust pipe, main power feeds, control systems, fuel lines, etc., shall be flexible in order to allow free movement of the genset on its isolators, and to prevent transmission of noise and vibration.

3.3 MATERIALS AND WORKMANSHIP

A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.

B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.

C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.

D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.

E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.

F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.4 SPECIFIC PROTOTYPE TESTS

A. Engine

1. Performance (part-load, full load, lug)
2. Oil Consumption
3. Fuel Consumption
4. Exhaust Emissions
5. Noise Levels, Mechanical and Exhaust
6. Startability (cold and hot ambients)
7. Piston, Ring, and Liner Wear Rates
8. Piston Structural Integrity
9. Lubrication System Evaluation
10. Cooling System Evaluation
11. Valve Train Overspeed Qualification
12. Deep Thermal Cycle Endurance

13. Field Endurance

B. Generator

1. Temperature Rise (per NEMA MG1-22.40 & Mil. Std. 705B-680.1b)
2. Motor Starting
3. Wave Form Harmonic Analysis
4. Insulation Resistance (per Mil. Std. 705B-301.1)
5. High Potential Test (per Mil. Std. 705B-302.1)
6. Winding Resistance (per Mil. Std. 705B-401.1)
7. Saturation, Open Circuit (per Mil. Std. 705B-410.1)
8. Saturation, Short Circuit (per Mil .Std. 705B-411.1)
9. Saturation, Rotating Exciter (per Mil. Std. 705B-414.1)
10. Reactance and Impedance, Negative Sequence (per Mil. Std. 705B-422.1)
11. Reactance, Zero Sequence (per Mil. Std. 705B-423.1)
12. Overspeed (at 150% and per Mil. Std. 705B-505.3)
13. Phase Sequence (per Mil. Std. 705B-507.1)
14. Phase Voltage Balance (per Mil. Std. 705B-508.1)
15. Circulating Currents (per Mil. Std. 705B-509.1)
16. Regulator Voltage Adjustment (per Mil. Std. 511.1)
17. Voltage Waveform Oscillographic (per Mil. Std. 705B-601.1)
18. Voltage Waveform Harmonic (per Mil. Std. 705B-601.4)
19. Voltage Frequency Curve
20. Voltage Dip and Rise
21. Voltage Drift
22. Voltage Spike Check
23. Voltage Sensing Loss
24. Voltage Waveform Deviation
25. No Load Losses
26. Efficiency
27. Overload Capability
28. Short Circuit Capability
29. Electromagnetic Interference (EMI) Evaluation
30. Telephone Influence Factor (TIF)

C. Generator Set

1. Mechanical Compatibility
2. Structural Integrity
3. Mounting Evaluation
4. Wiring Compatibility
5. Control Panel Functionality
6. Linear Vibration Measurement
7. Torsional Vibration Analysis (per Mil. Std. 705-504.2)
8. Radiator Performance
9. Noise Level
10. Transient Response, Voltage and Frequency
11. Load Performance

12. Safety Shutdowns and Alarms
13. Start/Stop Evaluation

3.5 SPECIFIC PRODUCTION TESTS

A. Each engine, generator, and generator set shall be subjected to production performance tests and quality controls to insure reliable operation. These tests and controls shall include but not be limited to:

1. Special oil additive for leak detection.
2. Specific observances of engine blow-by, slobber, combustion gas leaks, inlet air leaks, excessive vibration, and unusual noise.
3. Fuel system setting confirmation which shall not be altered to rectify non-conformance to established performance specifications.
4. Retest after any change affecting airflow through the engine, fuel injected into the engine, engine combustion, or any reassembly which potentially affects mechanical integrity.
5. Periodic extended tests to confirm baseline data.
6. Recording of:

    a. Engine

        1) Corrected Power
        2) Full Load Speed
        3) Full Load Torque
        4) Corrected Specific Fuel Consumption
        5) Turbo Boost
        6) Bank-to-Bank Differential
        7) Inlet Air Restriction
        8) High Idle Speed
        9) Low Idle Speed
        10) Engine Inlet-Outlet Temperature Differential
        11) Fuel Pressure
        12) Oil Pressure
        13) Oil Temperature
        14) Fuel System Setting
        15) Response (RPM-Time) for Full Load Removal
        16) Timing
        17) Barometric Pressure
        18) Water Vapor Pressure
        19) Inlet Air Temperature
        20) Fuel Density

    b. Generator

        1) High Potential Test, Before and After Load Runs
        2) Voltage Gain Range at Load

3) Voltage Level Range
4) Regulation Adjustment at 0.8 PF
5) Voltage Droop Range, when applicable
6) Circulating Current Between Phases
7) Voltage Balance Between Phases
8) Residual Voltage

c. Torsional and linear vibration analysis of generator set.
d. Individual testing of major components.
e. Individual balancing and weight control of rotating/reciprocating components.

3.6 FACTORY TESTING

A. Each complete diesel generator set shall be factory tested at its full load prime and standby rating. This test shall be conducted with resistive and reactive load banks, at 0.80 power factor and shall demonstrate governor transient response for pickup of full load and rejection of full load. Certified copies of the factory test shall be furnished to the Architect within three (3) weeks following the date of the test.

3.7 JOBSITE ACCEPTANCE TESTS

A. Jobsite testing shall be conducted as described below after start-up is complete. Start-up shall include battery installation, fuel system priming, and a general inspection of the exhaust and ventilation systems to ensure proper installation and operation. The generator set shall then be started and observations shall be made by a factory trained technician as to proper operation of the engine, generator, generator controls, and all external engine generator support systems. All safety shutdowns and prealarm devices shall be checked for proper operation of the circuit and corresponding indicating lights on the control panel and at the remote annunciator panel, in the presence of the Owner and the Electrical Engineer. Phase rotation shall be checked.

B. After start-up is complete, load testing shall be conducted in accordance with the latest adopted edition of NFPA 110. The testing shall consist of an on-site installation test utilizing available connected load by initiating a normal power failure and a transfer to emergency of all automatic and/or manual transfer switches. The prime mover shall be in a cold start condition and the following shall be observed and recorded:

1. Time delay engine start.
2. Crank time until prime mover starts and runs.
3. Time required for prime mover to come up to operating speed.
4. Record voltage and frequency overshoot.
5. Time required to achieve steady state operation with all transfer switches transferred to the emergency position.
6. Record voltage, amperage and frequency.
7. Record prime mover oil pressure, water temperature and battery charge rate at five (5) minute intervals for the first fifteen (15) minutes, and at fifteen (15) minute intervals thereafter.

8. Continue building load test for two (2) hours and continue to record readings at fifteen (15) minute intervals. Additionally, observe and record load changes and the resultant effect on voltage and frequency.

C. After completion of the above test, allow the prime mover to cool for five (5) minutes. At this point, a test shall be conducted for four (4) hours at full station power utilizing available building load, supplemented with resistive load banks. Once the prime mover has been started and has reached rated voltage and frequency, apply full rated load in one (1) step. Record the data listed in on-site testing above for the first load acceptance and every fifteen (15) minutes thereafter until the completion of the four (4) hour test period.

D. After tests are complete, provide the following additional tests and record the appropriate data:

1. Observe and record cyclic crank/overcrank lockout duration.
2. Observe and test all safety shutdown circuits specified.

E. After all testing is completed and accepted by the Owner, provide a detailed test record in six (6) sets including all recordings and test logs. Also, provide a letter on manufacturer's letterhead indicating that testing has been successfully completed and the emergency system is in first class operating condition.

F. The testing organization shall be responsible for providing all necessary equipment and materials to perform the above tests, including, but not limited to:

1. Load banks
2. Interconnecting cables of appropriate length with interconnections as required
3. Cable lugs
4. Overcurrent protection device(s) between generator and load bank(s) (if required).

G. Fuel for testing the emergency generator shall be obtained from the main fuel tank. The fuel tank shall be filled by the Electrical Subcontractor using No. 2 diesel fuel oil before and after the load bank test.

H. After all systems have past testing parameters and is complete and accepted, the Electrical Subcontractor shall arrange with the generator set supplier to drain, flush and refill the engine with a fresh supply of lubricating oil and filters.

I. Manufacturer shall provide copies of test reports upon request.

3.8 TRAINING

A. The Electrical Subcontractor shall provide a training session for up to 4 Owner's representative for 2 normal workdays at a jobsite location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, and major components within the assembly.

C. The training program shall include the following:

1. Review of the project one-line drawings and schedules.
2. Review of the factory record shop drawings.
3. Review of all equipment in the emergency electrical distribution system.
4. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
5. Provide three ring binders to participants complete with copies of drawings and other course material covered.

3.9 OPERATION INSTRUCTIONS AND MAINTENANCE MANUALS

A. After completion of work and start-up of the equipment at the jobsite, deliver to the Contracting Officer, copies of operating instructions, maintenance manuals and drawings presenting full details for care and maintenance of each item of equipment furnished and/or installed under this Contract.

B. Each manual shall contain the operating and maintenance information and parts lists furnished by the manufacturer, for all equipment provided in the Contract. When necessary, provide supplemental drawing to show system operation and servicing and maintenance points. For all electrical components, furnish wiring and connection diagrams. Manuals shall include instructions required to accomplish specified operation and functions. Data shall be neat, clean, legible copies. Drawings shall be accordion folded. Non-applicable information shall not be included. Five (5) sets of manuals shall be furnished to the Owner.

C. Switchgear drawings and wiring diagrams shall be furnished complete and up to date at the completion of start-up and system acceptance by the Owner. Drawings and wiring diagrams shall include any field modifications or changes to reflect actual as built conditions.

END OF SECTION