PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Standby generators.
   2. Automatic Transfer Switches (ATS).
   3. System start-up services.
   4. Battery charging system testing.
   5. Load bank testing.
   6. Integral system testing.
   7. System demonstration.

B. Refer to Division 26 Section “Static Uninterruptible Power System Testing and Commissioning”.

C. All equipment, including load banks, measuring instruments, cables, connectors, etc. required for the site testing of the complete generator installation shall be provided by the generator manufacturer’s factory authorized firm. The electrical contractor shall assist and coordinate with the generator manufacturer’s factory authorized firm in the administration and performance of the site testing.

1.2 SUBMITTALS

A. Factory test reports.

B. Field test reports and other documentation including a description of the test procedures and inspections with results listed for each test performed in a type-written format. Include results of tests, inspections and retests.

C. Battery and battery charging test results and inspections required in this specification.

D. Infrared scanning reports with pictures printed in a final report with any deficiencies and actions taken to rectify.

1.3 QUALITY ASSURANCE
A. Provide a list of testing equipment with make and model numbers. Test Equipment shall have current calibration validation.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 SYSTEM START-UP

A. 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.
   2. Perform generator testing, ATS testing and integral system testing including both generators and ATS.

B. Visual and Mechanical Inspections:
   1. Compare equipment nameplate data with drawings and specifications.
   2. Inspect physical and mechanical condition.
   3. Inspect anchorage, alignment and grounding.
   4. Very unit is clean.
   5. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding parts (ATS).
   6. Verify ATS warnings are attached and visible.
   7. Verify tightness of all control connections.

C. Generator Electrical and Mechanical Tests:
      a. Machines larger than 200 horsepower (150kW): Test duration shall be ten minutes minimum. Calculate the polarization index.
      b. Machines 200 horsepower (150kW) or less: Test duration shall be one minute minimum. Calculate the dielectric-absorption ratio.
   2. Test protective relays and main circuit breakers.
   3. System Integrity Tests: Methodically verify proper installation, anchorage, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
   4. Test phase rotation, phasing and synchronized operation as required by the application.
   5. Functionally test engine shutdown for low oil pressure, over-temperature overspeed, and other protective features as applicable.
   6. Perform vibration test for each main bearing cap.
   7. Verify correct functioning of the governor and regulator.
8. **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.

9. **Battery Tests:** Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform a battery system integrity load test and a capacity load test.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

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

11. **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.

12. **Exhaust Emissions Test:** Comply with applicable government test criteria.

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

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

15. **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** <Insert number> locations **on the property line** <Insert location for measurement>, and compare measured levels with required values.

D. **ATS Electrical and Mechanical Tests:**

1. Inspect bolted electrical connections for high resistance using one of the following methods:
   a. Use of low-resistance ohmmeter.
   b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
   c. Perform thermographic survey.

2. Perform manual transfer operation.

3. Verify positive mechanical interlocking between normal and alternate sources.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.

5. Perform a contact/pole-resistance test.
6. Verify settings and operation of control devices.
7. Calibrate and set all relays and timers.
8. Verify phase rotation, phasing, and synchronized operation as required by the application.
9. Perform automatic transfer test:
   a. Simulate loss of normal power.
   b. Return to normal power.
   c. Simulate loss of emergency power.
   d. Simulate all forms of single-phase conditions.
10. Verify correct operation and timing of the following functions:
    a. Normal source voltage-sensing relays.
    b. Engine start sequence.
    c. Time delay upon transfer.
    d. Alternate source voltage-sensing relays.
    e. Automatic transfer operation.
    f. Interlocks and limit switch function.
    g. Time delay and retransfer upon normal power restoration.
    h. Engine cool down and shutdown feature.

E. ATS Test Values:
1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2. Bolt torque levels shall be in accordance with manufacturer’s published data.
3. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer’s published data. If manufacturer’s published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
4. Control devices shall operate in accordance with manufacturer’s published data.
5. Phase rotation, phasing, and synchronization shall be in accordance with system design specifications.
6. Automatic transfers shall operate in accordance with manufacturer’s design.
7. Operation and timing shall be in accordance with manufacturer's and system design requirements.

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

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

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

I. Report results of tests and inspections in writing. Record adjustable relay and breaker 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.
3.2 LOAD BANK TESTING

A. Perform load bank testing as recommended by the manufacturer or as a minimum:

1. Four hour burn-in test at 100%.
   a. At end of four hour burn-in test perform infrared scanning of electrical connections.

2. Perform block loading tests of generator system including:
   a. 25% for 30 min
   b. 50% for 30 min
   c. 75% for 60 min
   d. 100% for 10 min
   e. 75% for 110 min

B. Report results of load bank tests in writing. Attach a label or tag to equipment indicating satisfactory completion of load bank tests.

3.3 INTEGRAL POWER SYSTEM TEST

A. An integral power system test shall be performed for projects including the installation of an uninterruptible power system (UPS).

B. The integral power system test shall be dictated and performed by the UPS system provider.

C. The generator provider shall provide assistance as required where compatibility issues between the UPS systems and the generator arise including:

1. Compatibility between the UPS system and the generators, i.e. harmonics shall not influence voltage regulation and the UPS input filter shall not affect the generator.

2. Ability of the UPS system to synchronize the generator output.

3. Ability of the UPS system to transfer the load from UPS system to maintenance bypass and back while on generator power.

4. Ability of the UPS to limit battery recharge current while on generator power.

3.4 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 1 Section "Demonstration and Training."

END OF SECTION