PART 1 GENERAL

1.1 RELATED SECTIONS

.1 Electrical Starting and Testing General Requirements Section 16070

.2 Electrical Performance Testing by [Owner’s] [Contractors] Testing Agent Section 16072

.3 Electrical Performance Testing by Owner Section 16073

1.2 INTENT

.1 Read this Section in conjunction with Section 16070, Electrical Starting and Testing – General Requirements and other related electrical starting and test sections.

1.3 SCOPE

.1 References to completion of the work in other sections requires that full function testing and operational demonstration be performed for each and every system included in the work of Division 16. Testing and startup for each system by Division 16 to include the following activities:

.1 Pre-start visual inspection and testing.
.2 Startup for energization and full functional demonstration.
.3 Performance Testing and operational checks.
.4 All corrective and follow-up actions and any re-testing as necessary.

.2 Prior to the final demonstration and instructional seminars required, test and check all portions of the electrical system for satisfactory operation. All tests to be done in the presence of the Owner’s Commissioning Agent and/or his representative, suitably logged, tabulated, signed and incorporated in project documentation.
.3 On site (field acceptance) testing, commissioning and verification to include, but not be limited to the following:

(Spec Note: Edit this carefully to ensure responsibility for tests is properly assigned.)

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PART 2 PRODUCTS

2.1 N/A

PART 3 EXECUTION

3.1 GROUNDING RESISTANCE TESTING

(Spec Note: where independent test agent is used specify test in section 16072.)

.1 Measure ground resistance of ground grids with earth test megger to verify compliance with CSA C22.2 No. 0.4-1982 and Canadian Electrical Code.

.2 Perform tests before energizing electrical distribution.

.3 Provide test report documenting successful test results.

3.2 BASIC ELECTRICAL STARTUP AND TESTING

.1 Energizing Main Electrical System

.1 Prior to energizing main electrical system:

.1 Verify supply authority voltage and phase rotation.

.2 Ensure all independent testing as specified in Section 16072 has been completed and deficiencies have been corrected.

.3 Megger all feeders and record results on approved test report forms.

.2 Testing of Wiring and Wiring Devices

.1 Test conductors at switchboards, distribution centres and panelboards for insulation resistance to ground (megger test).

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation and circuitry.

.3 Load Balance Testing

.1 Perform load tests with as many building loads on as possible three months after Practical Completion.
.2 Test load balance on all feeders at distribution centres, motor control centres and panelboards.

.3 At the consultants discretion and if load unbalance exceeds 15%, reconnect circuits to balance loads. Revise panelboard directories and wiring identification accordingly.

.4 Voltage Testing and Adjusting

.1 Test voltage at service entry point, motor control centres and secondary of transformers above 45 kVA. Record voltages at Substantial Completion during a normal work day. Repeat same three months after occupancy.

.2 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by the Consultant.

.5 Starting Motors

.1 Prior to starting motors:

.1 Confirm motor nameplate data with motor starter heater overloads, setting of MCPs and sizing of fuses.

.2 Verify rotation.

.3 Ensure disconnects are installed.

.4 Confirm labelling of motors, disconnects and starters.

.2 Measure and record operating load amp readings for all three phase motors.

3.3 MOTOR CONTROL CENTRES AND STARTERS

.1 Ensure all starters are properly labelled prior to testing.

.2 (Spec Note: only include if section 16072 is used) Ensure all testing as specified in Section 16072 has been completed.

3.4 LIGHTING

.1 Function test all light switches, luminaires, dimmers and lighting control equipment such as photo-cells and time clock settings.

.2 Check operation of all battery operated emergency lighting units, exit lights, and connection of exit lights to emergency lighting units as specified.
.3 Record all photo-cell and time-clock settings.

### 3.5 STANDBY POWER GENERATION SYSTEM

#### .1 Factory Testing:

.1 Where testing takes place outside the Edmonton area, include the consultant’s travel and accommodation expenses in tender price.

.2 Perform torsional analysis test of engine and generator compatibility.

.3 Notify the Consultant ten days prior to testing to arrange for witness testing.

.4 Where required by Consultant arrange for factory test to be carried out in conjunction with automatic transfer equipment, load sharing controllers and/or co-generation controllers.

.5 Perform a five hour load test using a portable test bank. Perform test for four hours with load applied in 20% steps every 30 minutes until full load is applied and one hour at 110% full load. Record following at 15 minute intervals during the entire test:

1. Kilowatts
2. Amperes
3. Voltage
4. Frequency
5. Oil Pressure
6. Coolant Temperature

.6 Test response of governor (droop or isochronous) applying 20% load and 100% load in one step. Use a storage oscilloscope or strip chart recorder to determine response time, voltage and frequency fluctuations during test.

.7 Test voltage regulator and compare for conformance to manufacturer’s product data.

.8 Record noise level measurements in dB at various locations around unit and area surrounding exhaust port.

.9 Submit certified test results for approval by Consultant.

#### .2 Starting Standby Power Generation System:

.1 Prior to energizing power generation units on site:
.1 Ensure generating system is disconnected from normal power supply.

.2 Ensure all auxiliary support devices are operational, including ventilation and exhaust systems.

.3 Ensure that engine has proper lubricant levels, coolant levels and fuel supply.

.4 Ensure all testing on emergency distribution equipment and transfer switch as specified has been completed.

.3 Site Testing:

.1 (Spec Notes: use this for all buildings with the exception of Health Care Facilities) Conduct Site Testing in conjunction with manufacturer and in presence of the Consultant.

.2 Simulate power failure including operation of:

.1 Transfer switch
.2 Automatic starting cycle
.3 Automatic shutdown and return to normal

.3 Test all alarm and shutdown circuits by simulating conditions. Closing or opening of appropriate sensor contacts mechanically is not acceptable.

.4 Record noise level measurements in dB at various locations in generator room and area surrounding exhaust port.

.5 Perform four-hour full-load testing utilizing portable test bank and as many of building loads as possible. Record following at 15 minute intervals during entire test:

.1 Kilowatts
.2 Amperes
.3 Voltage
.4 Frequency
.5 Oil Pressure
.6 Coolant Temperature
.7 Room Temperature

.6 Fuel required for unit testing to be provided by Division 16.

.7 Provide full rated block load test and record frequency, voltage and current using suitable strip chart to verify dynamic response of unit to CSA Standards. Submit test results to the Consultant upon completion.

Or
.4 Site Testing: *(Spec Note: use this article for onsite testing of Generators in Health Care Facilities)*

.1 Operational Test - the following shall apply:

.1 With the engine in a “cold start” condition and the emergency load at its normal operating level, a power failure shall be simulated by opening all switches or breakers that supply the normal power to the building or facility. The test load shall be that load which is normally served by the emergency power system.

.2 The operational test shall be continued for 1 h, after which normal power shall be restored to the building or facility and satisfactory transfer of the load and shutdown of the emergency generating set shall be demonstrated.

.3 The following data shall be observed and recorded:

.1 Time delay on start;

.2 Cranking time until the engine starts and runs;

.3 Time required to come up to operating speed;

.4 Time required to achieve a steady-state condition with all switches transferred to the emergency position;

.5 Voltage, frequency, and amperes at startup and at any observed change in load;

.6 Engine oil pressure, water temperature where applicable, and battery charge rate at 5 min intervals for the first 15 min, and at 15 min intervals thereafter;

.7 Time delay on retransfer for each transfer switch; and

.8 Time delay on engine cooldown and shutdown.

.2 Full Load Test - the following shall apply:

.1 Following the test prescribed in Clause 6.5.16.2, the emergency set shall be subjected to a 4 h 100% load test.

.2 Test shall be conducted using a load bank. Full load shall equal the nameplate kW rating of the emergency generator set less the applicable derating factors for site conditions. A unity power factor is acceptable for onsite testing, provided that rated load tests at the rated power factor have been performed by the manufacturer of the emergency generator set prior to shipment. A certificate of
acceptability demonstrating performance at 0.8 power factor at rated power may also be acceptable.

.3 The full load test may be initiated by any method that will start the engine and, immediately upon reaching its rated speed, pick up the anticipated emergency load or 80% of the full load in one step.

.4 The data listed in Clause 6.5.16.2(c) shall be recorded at first load acceptance and every 15 min thereafter until the completion of the test period.

.3 Cycle Crank Test – the following shall apply:

.1 The engine shall be prevented from running by utilizing any method recommended by the manufacturer. The control switch shall then be placed in the “run” position to cause the engine to crank.

.2 The engine starting system shall provide a cranking cycle consisting of:

.1

.2 three 10 s crank attempts separated by 10 s rest periods.

.3 The crank cycle shall be repeated a second time to demonstrate that the batteries or compressed air have sufficient capacity for a total cranking time of 60 s as specified in Clauses 6.5.13.1(a) and 6.5.13.2(a).

.4 The time required to recharge the batteries or the compressed air shall be demonstrated to meet the requirements of Clauses 6.5.13.1(c) and 6.5.13.2(c) as appropriate.

.4 Safety Shutdown and Alarms

.1 The emergency supply shall be tested as recommended by the manufacturer to ensure that all safety shutdowns and alarms respond as specified in Table 8.

.5 Ventilation

.1 During the tests described in Clauses 6.5.16.2 and 6.5.16.3, it shall be demonstrated that the ventilating system meets the requirement of Clause 6.5.9.2.

.6 Voltage and Frequency
.1 The voltage and frequency variations during load switching shall be measured and recorded as outlined in the following procedure:

.1 install continuous strip chart recorders to record frequency and voltage variations during load-switching procedures;

.2 delay each load change until steady-state conditions exist;

.3 switch increments to include typical loads such as:

.1 no load to full load to no load;
.2 no load to 70% load to no load;
.3 40% load to 60% load to no load; and
.4 60% load to 80% load to no load.

.7 Oil Analysis

.1 After 24 h of running time of the installed generator, extract a sample of the engine oil and have an analysis done to detect the presence of any copper, bronze, water, glycol, etc. The test results should be saved for comparison with future routine scheduled analysis.

3.6 FIRE SAFETY SYSTEMS

.1 Prior to requesting verification of the Fire Alarm System by the Owner, Division 16 and the Fire Safety system manufacturer's technical staff shall:

.1 Inspect system in conjunction with the manufacturer to ensure that fire alarm system is correctly installed, connected and fully operational in accordance with requirements of the Contract Documents and Manufacturers recommendations. This shall include all auxiliary equipment connected to fire alarm system such as elevators, central station tie-in, fan shut-down, sprinklers, door hold-open devices, etc.

.2 Ensure that any subsequent work remaining to be performed on the above-noted items will not invalidate examinations and tests performed during verification procedure.

.3 Ensure that operation and maintenance data has been submitted.

.4 Ensure that spare parts and maintenance materials have been delivered.

.2 Certify to the [Choose One] Construction Manager] [Owner] in writing that above prerequisites have been fulfilled and specifying known exceptions in the form of a list of items to be completed or corrected, prior to proceeding with verification.
.3 The Verification Agent will proceed with verification, or advise [(Choose One) Construction Manager] [Owner] that prerequisites are not adequately fulfilled.

.4 Fire Alarm Verification:

.1 Assist and cooperate with the Verification Agent in verification procedure.

.1 Provide the following equipment:

1 Velometer
2 Artificial Smoke
3 Rate of Rise Heat Detector Tester
4 Minimum of four portable communication devices.

.2 Do not proceed with the verification unless the following parties are present at all times during verification procedures:

1 Electrical Contractor.
2 Fire Alarm System Manufacturer’s Representative.
3 Consultant verification representative.

.3 Disassemble and reassemble system components.

.4 Disconnect and reconnect wiring.

.5 Perform required field adjustments.

.6 Repair defective work and replace defective components.

.7 Perform all other work on system required by verification procedure.

3.7 DOOR SECURITY AND MONITOR SYSTEM

.1 Prior to function testing of system, perform following in conjunction with manufacturer:

1 Ensure all equipment is properly installed and all terminations completed.

2 Prior to testing, ensure all programming is complete and software is performing correctly.

3 Ensure all magnetic locks, door contacts and card readers are operational.

.2 Manufacturer shall function test system as follows:

1 Door Supervision System:
.1 Check installation and operation of all door contacts and control panels, including automatic dialler, if specified.

.2 Confirm proper door labelling on all annunciators and main control.

.3 Record results on approved test forms.

.2 Cardpad/Prox Reader Access System:

.1 Check installation of all equipment.

.2 Confirm operation of each door in accordance with sequence of operation provided. Check door contacts, proper latching of magnetic locks, keypad operation and exit pushbuttons.

.3 Confirm correct labelling of doors on annunciators, CRT monitor and in programming.

.4 Confirm system programming and printer operation.

.5 Check remote alarming via automatic diallers.

.6 Confirm proper sequence of Operation during Fire Alarm and Emergency Power condition.

.3 Check all interconnections with other systems.

.3 Record results on Commissioning Check Sheets.

.4 Upon completion demonstrate satisfactory operation to the Owner's Commissioning Agent.

3.8 PUBLIC ADDRESS SYSTEM

.1 Prior to function testing of system, perform following in conjunction with manufacturer:

.1 Manufacturer shall install all head-end equipment and terminate all wiring.

.2 Test system for proper operation and sound level readings taken. Adjust equipment and speaker settings to meet levels specified and documented.

.3 Verify correct operation of all paging zones, all-page and other system functions.

.2 Manufacturer shall function test system as follows:
.1 Confirm operation of all sound equipment including amplifiers, pre-amplifiers, tuner, tape deck, microphone, speakers and any other auxiliary equipment.

.2 At various settings of amplifier, record sound pressure levels (SPL) under each speaker and half-way between each speaker.

.3 Verify all interconnections with other systems for proper operation.

.3 Record results on Commissioning Check Sheets.

3.9 ELEVATOR SERVICE

.1 Prior to energizing feeders for elevator equipment, megger feeders and record results. Confirm size of disconnects and fuses with elevator equipment suppliers.

.2 Coordinate energizing elevator feeders with elevator equipment supplier. Confirm interconnections to Fire Alarm System prior to Fire Alarm Verification.

.3 Function Emergency Power supply to elevators to ensure operation complies with design parameters.

.4 Function test system as specified in Section 16073 in the presence of the Owner’s Representative.

3.10 DOOR ENTRANCE TV INTERCOM SYSTEM

.1 Check installation of all equipment.

.2 Ensure speakers are tapped and amplifier and noise generator set as required to meet specification levels.

.3 Function test system as specified in Section 16072 in the presence of the Owner’s Representative.

3.11 NURSE CALL SYSTEM

.1 Check installation of all equipment.

.2 Terminate all wiring.

.3 Check software for correct operation of all features.

.4 Program in user information.

.5 Function test system as specified in Section 16073 in the presence of the Owner.
3.12 RF TELEVISION SYSTEM

.1 Ensure all equipment is properly installed and wiring correctly terminated.

.2 Test system for proper operation. Verify signal adequacy at each outlet using a field strength meter and record results.

.3 Function test system as specified in Section 16073 in the presence of the Owner's Representative.

3.13 TELEPHONE SYSTEM

.1 Ensure all equipment is properly installed and wiring correctly terminated.

.2 Ensure all handsets operate properly.

.3 Function test system as specified in 16073 the presence of the Owner's Representative.

3.14 UPS SYSTEM

.1 Ensure all equipment is properly installed and wiring correctly terminated.

.2 Ensure capacity and operation meets specified limits.

.3 Verify operation and remote annunciation of all alarms.

3.15 TELEPHONE/DATA CABLING

.1 *(Spec Note: Quote applicable section.)* Refer to section 16743.

END OF SECTION