

# **C282-05 “Emergency Electrical Power Supply for Buildings”**

## **11 Operation and maintenance program**

### **11.1 General**

#### **11.1.1 Operation and maintenance**

The emergency electrical power supply equipment shall be operated and maintained in accordance with the manufacturer’s recommendations and instruction manuals and the requirements of Clauses 11.1.2. to 11.5.

*Note: See Clause B.19 for commentary on this Clause.*

#### **11.1.2 Inspection, testing, and maintenance log**

A permanent log of the inspection, testing, and maintenance of the emergency electrical power supply system shall be maintained in accordance with the manufacturer’s manual of operating and maintenance instructions and cover at least the items specified in Tables 2 to 6.

This log shall be kept on site and shall include

- (a) the date on which an inspection, testing, and maintenance exercise was carried out;
- (b) the name(s) of the person(s) who performed the inspection, testing, and maintenance;
- (c) notes on any unsatisfactory conditions observed or discovered and the steps taken to correct such conditions; and
- (d) copies of the design and installation performance test certificates.

### **11.2 Instruction, tools and spare parts**

#### **11.2.1 Manual of operating and maintenance instructions**

##### **11.2.1.1**

At least two copies of a manual containing mechanical and electrical drawings and instructions for the operation and maintenance of the emergency generator equipment shall be provided. It shall cover all of the elements affecting the reliable operation of the emergency electrical power supply, including the engine generator set and associated accessories, the generator control panel, the protective devices, and the transfer switch(es).

##### **11.2.1.2**

The manual should be available in both English and French.

##### **11.2.1.3**

One copy of the manual shall be kept in the safe custody of the person responsible for overall control of the operation and maintenance program.

#### **11.2.1.4**

Copies of the manual to be used by the operating and maintenance staff shall be kept in a location convenient for staff use.

#### **11.2.2 Tools**

Any special tools and gauges needed for routine maintenance shall be kept in a secure location accessible to the operating and maintenance staff when necessary.

*Note: A possible suitable location is the area where the engine generator set is installed.*

#### **11.3 Annual test**

The emergency generator set shall be subjected annually to a 2 h full-load test (See Table 5) in accordance with Clauses 10.3.2 to 10.3.4. In parallel generator set installations, each generator may be load tested individually in synchronization and load sharing is demonstrated. All inspection covers shall be opened or removed, as necessary, to provide access to all electrical connections during this test.

*Note: See Clause B.18 for commentary on this Clause.*

#### **11.4 Periodic operational tests**

The emergency electrical power supply system shall be completely tested as specified in Table 3 at least once a month in all facilities.

### **11.5 Maintenance**

#### **11.5.1 General**

The emergency electrical power supply shall be maintained as specified in the manufacturer's manual of operating and maintenance instructions, provided that the manual covers at least the items specified in Tables 2 to 6. The owner's representative shall ensure that qualified personnel with appropriate training, experience, and supervision perform the maintenance work.

#### **11.5.2 Frequency of procedures**

The minimum frequency of inspection, testing, and maintenance procedures shall be as specified in Tables 2 to 6. Additional requirements may be specified by manufacturers, operators, or authorities having jurisdiction and shall be permanently recorded in the manual of operating and maintenance instructions and the log.

#### **11.5.3 Records**

A permanent log of the maintenance work (including inspections and tests) shall be maintained in accordance with the manufacturer's manual of operating and maintenance instructions (see Clause 11.5.1). The permanent log shall be kept on site and shall include at least the following:

- (a) the date on which the work was done;
- (b) a note of parts replaced;

- (c) a note of any unsatisfactory condition discovered and the steps taken to correct it;
- (d) the name of the person who performed the work; and
- (e) A note verifying that any switches or controls that were deactivated for safety purposes during maintenance have been restored to their intended operating condition.

**Note:** A permanent logbook meeting all the requirements of this standard is available from CSA (C282 Logbook)

## **11.5.4 Safety**

### **11.5.4.1**

If the maintenance procedure involves a risk of injury because of moving parts or energized electrical parts, step shall be taken before the work is begun to deactivate all automatic and manual control devices for the parts with which contact will be named.

### **11.5.4.2**

Signs shall be installed on the equipment at the entrance to the enclosure and on the door to the room housing the equipment stating that the equipment is automatically controlled and could start at any time.

## **11.5.5 Visual inspection of fuel (clear and bright test)**

### **11.5.5.1 General**

All fuel supplied to the emergency generator set shall be clean and clear and bright as specified in Clause 11.5.5.4. Immediately upon completion of the annual fuel oil inventory maintenance specified in Table 5, the fuel oil shall be tested to verify that it is clear and bright. If the fuel fails the test, tank shall be flushed to remove built-up sludge and impurities.

**Note:** The purpose of this test is to detect possible water or solid contaminants in diesel fuel by visual inspection. The test method is based on ASTM D 4176.

### **11.5.5.2 Description**

The fuel shall be placed in a transparent bottle or container (Clause 11.5.5.3) and examined to determine whether it is clear and bright. Samples for the clear and bright test shall be obtained from the bottom of the storage and day tanks.

### **11.5.5.3 Equipment**

A dry, capped, clear glass bottle or container capable of holding 250 to 1000 mL of liquid shall be used. The bottle or container shall have a clear, undistorted bottom and be thoroughly washed before the test.

### **11.5.5.4 Procedure**

The following procedure shall be followed:

- (a) Wash the fuel sample bottle or container before gathering each sample.

- (b) Let the sample settle for 1 min to remove air bubbles.
- (c) Observe the sample against a light background for a clear and bright condition. Swirl the bottle or container to create a vortex (free water and solids tend to collect beneath the vortex).

#### **11.5.5.5 Interpretation of test results**

The samples shall be clear and bright. Record the visual clarity as clear and bright or not clear and bright. Record whether particulate matter or water was seen at the bottom of the vortex.

**Note:** *The term “clear and bright” has no relation to the natural fuel oil colour. Fuel oil colour varies from water white, to straw colour, to amber, depending on the processing and/or crude source. Clear and bright fuel has no floating or suspended matter. Brightness is a quality independent of the sample colour and refers to the lack of suspended or free water in the sample. Bright fuel tends to sparkle.*

**Table 1**  
**Safety indicators and shutdowns**  
(See Clauses 7.4.1, 7.4.2, and 10.5)

Indicator/function (at battery voltage)	CV ( see Clause 7.4.1(d))	RA (see Clause 7.4.1 (e))	S	Notes
1. Overcrank	X	X	X	----
2. Low engine temperature (i.e., too low for reliable start)	X	X	----	----
3. High engine temperature pre-alarm	X	X	----	----
4. High engine temperature	X	X	X	1
5. Low lube oil pressure pre-alarm	O	O	----	----
6. Low lube oil pressure	X	X	X	1
7. Overspeed	X	X	X	1
8. Low fuels (signal less than 2 h of fuel remaining)	X	X	----	----
9. Emergency electrical power supply system supplying load	O	----	----	2
10. Control switch not in automatic position	X	----	----	----
11. Low voltage in battery	X	X	----	----
12. Lamp test	X	----	----	----
13. Contacts for local and remote common alarm	X	X	----	----
14. Audible alarm silencing switch	----	X	----	----
15. Low starting air pressure (if applicable)	X	X	----	----
16. Low starting hydraulic pressure (if applicable)	X	X	----	----
17. Air shutdown damper (if applicable)	X	X	----	----
18. Remote emergency stop (if applicable)	----	O	O	----
19. Low coolant level (if applicable)	X	X	----	----
20. Ventilation dampers not open	O	O	----	----
21. Day tank containment leak sensing	X	X	----	----
22. Automatic transfer switch in bypass mode ( if applicable)	X	X	----	3
23. Underfrequency/underspeed	O	----	----	----
24. Overcurrent	O	----	----	----
25. Undervoltage	O	----	----	----
26. Overvoltage	O	----	----	----
27. Main disconnect open	X	X	----	4

**Legend:**

CV – *Control-panel-mounted visual indicator*

RA – *Remote audible indicator*

S – *Shutdown of emergency power system*

X – *Required*

O – *Optional*

**Notes:**

(1) To ensure that the emergency power system is operational for as long as possible, shutdown should be delayed until failure is imminent. The setting of Item 4 shall be not less than 110% of normal temperature, the setting of Item 6 shall be not more than 40% of normal pressure, and the setting of Item 7 shall be not less than 115% of normal speed.

(2) An ac ammeter is acceptable for this function.

(3) An automatic transfer switch requires a remote audible safety indicator for both the automatic and bypass modes.

(4) The main disconnect open indicator should be included with the common “generator trouble” alarm indication on the fire alarm panel.

**Table 2**  
**Weekly inspection, test, and maintenance requirements**  
(See Clauses 6.11.2, 10.7, 11.1.2, 11.5.1, and 11.5.2 and Tables 3 to 5.)

<p>1. Consumables:</p> <p>(a) Inspect day tank fuel level (gas pressure) and main tank level (gas pressure) (if applicable). Minimum 2 h supply required (see Clause 7.3.1).</p> <p>(b) Inspect lubricating oil level.</p> <p>(c) Inspect engine coolant level.</p> <p>(d) Inspect engine, generator, fuel tank(s), and cooling systems for leakage.</p> <p>(e) Inspect for proper operation of fuel transfer pump (if applicable).</p> <p>(f) Inspect fuel filter for contamination if filter is equipped with a transparent bowl.</p>
<p>2. Starter system:</p> <p>(a) Inspect electric starter for cleanliness, mounting, and terminal security.</p> <p>(b) Air starter:</p> <p>(i) Inspect air tanks for pressure.</p> <p>(ii) Inspect valves for leakage.</p> <p>(iii) Test auxiliary engine and compressor for proper operation.</p> <p>(iv) Bleed off any condensation.</p>
<p>3. Batteries and charging equipment:</p> <p>(a) Inspect all battery cells for correct electrolyte fill level.</p> <p>(b) Test all battery cells for correct electrolyte specific gravity.</p> <p>(c) Inspect electrical connections for tightness and evidence of corrosion.</p> <p>(d) Inspect battery for cleanliness and dryness between terminals.</p> <p>(e) Inspect charger electrical connections for cleanliness and tightness.</p> <p>(f) Test charger for proper operation of float and equalize modes.</p>
<p>4. Engine:</p> <p>(a) Test lubricant and/or coolant heaters for proper operation.</p> <p>(b) Inspect governor control linkages and oil level (if applicable).</p> <p>(c) Inspect fuel pump oil sump (if applicable).</p> <p>(d) Inspect fan belts for correct tension and wear.</p>
<p>5. Control panel:</p> <p>(a) Inspect control panel covers for security.</p> <p>(b) Test annunciator lamps to confirm that they are operational.</p> <p>(c) Inspect control panel settings (ensure that the unit is ready for automatic start-up).</p> <p>(d) Test remote visual and audible trouble signals at the building fire alarm panel.</p>
<p>6. Inspect air control louvre settings to ensure proper operation.</p>
<p>7. Test emergency lighting unit(s).</p>
<p>8. Verify whether room temperature is above 10 °C.</p>
<p>9. Inspect generator and transfer switch room(s) for cleanliness and accessibility to all components of the emergency system.</p>
<p>10. Correct all defects found during inspections and tests.</p>
<p>11. Record all inspections, tests, and corrective actions in the log (see Clause 11.5.3).</p>

**Note:** *The person performing the work described in this Table shall have received appropriate training and be qualified to perform the specified tasks.*

**Table 3**  
**Monthly inspection, test, and maintenance requirements**  
 (See Clauses 10.7, 11.1.2, 11.4, 11.5.1, and 11.5.2 and Tables 4 and 5.)

1. All items specified in Table 2.
2. Test and verify the entire system as follows: (a) Simulate a failure of the normal electrical supply to the building. (b) Operate the system under at least 30% of the rated load for 60 min. (c) Operate all automatic transfer switches under load. (d) Inspect brush operation for sparking. (e) Inspect for bearing seal leakage. (f) Inspect for correct operation of all auxiliary equipment, e.g., radiator shutter control, coolant pumps, fuel transfer pumps, oil coolers, and engine room ventilation system(s). (g) Record the readings for all instruments in the log (see Clause 11.5.3) and verify that they are normal. (h) Drain the exhaust system condensate trap.
3. Inspect block heater hoses and wires.
4. Correct all defects found during inspections and tests.
5. Record all inspections, tests, and corrective actions in the log (see Clause 11.5.3).

**Note:** The person performing the work described in this Table shall have received appropriate training and be qualified to perform the specified tasks.

**Table 4**  
**Semi-annual inspection, test, and maintenance requirements**  
 (See Clauses 10.7, 11.1.2, 11.5.1, and 11.5.2 and Table 5.)

1. All items specified in Tables 2 and 3.
2. Inspect and clean engine crankcase breathers.
3. Inspect and clean all engine linkages
4. Lubricate the engine governor and ventilation system.
5. Test protective devices for proper operation.
6. Before start-up, perform two full cranking cycles (as specified in Clauses 10.4.1 and 10.4.2). Near the end of each cycle (and while still cranking), measure and record the lowest indicated battery voltage. If the measured voltage is less than 80% of the battery's rated voltage, replace the battery. Alternatively, perform a battery load test using a suitable load tester.
7. Inspect ventilation system belt(s).
8. Correct all defects found during inspections and tests.
9. Record all inspections, test, and corrective actions in the log (see Clause 11.5.3).

**Note:** Items 2 to 9 require special skills and shall be carried out by a qualified contractor, the system manufacturer, or individuals trained and certified by the system manufacture.

**Table 5**  
**Annual inspection, test, and maintenance requirements**  
(See Clauses 11.1.2, 11.3, 11.5.1, 11.5.2, 11.5.5.1, and B.20.)

<p>1. All items specified in Tables 2 to 4.</p>
<p>2. Control panel:</p> <ul style="list-style-type: none"> <li>(a) Open all inspection covers and inspect all electrical connections.</li> <li>(b) Test breakers for proper operation.</li> <li>(c) Clean insulators and bushings.</li> <li>(d) Test voltage regulator for proper operation.</li> <li>(e) Operate all moving parts to ensure that they move freely.</li> <li>(f) Clean and dress contacts as necessary.</li> <li>(g) Remove all dust.</li> <li>(h) Check gauge calibration.</li> <li>(i) With the generator set operating at full load (see Clause 11.3), conduct an infrared survey of all electrical connections to identify any high-resistance connections.</li> </ul>
<p>3. Engine:</p> <ul style="list-style-type: none"> <li>(a) Change engine lubrication oil and filters.</li> <li>(b) Test strength of coolant and chemical protection level of coolant inhibitors.</li> <li>(c) Change fuel filters, clean strainer(s), and verify that the fuel supply is open.</li> <li>(d) Inspect the exhaust system. Check and record the back pressure of the exhaust system to ensure that it complies with the engine manufacturer's requirements, and compare with previous readings.</li> <li>(e) Clean and lubricate linkages.</li> <li>(f) Inspect air filters.</li> <li>(g) Inspect all mechanical connections.</li> <li>(h) Inspect all electrical connections.</li> <li>(i) For spark ignition engines, inspect all components of ignition system(s) and service or replace as appropriate.</li> <li>(j) Inspect all external surfaces of heat exchanger(s) and clean as necessary.</li> <li>(k) Inspect all belts and hoses and replace if necessary.</li> <li>(l) Test and inspect ignition system(s). Replace any defective components.</li> <li>(m) Inspect coolant pump(s) for leaks and external wear (if belt driven, remove the belt(s) first).</li> </ul>
<p>4. Diesel fuel storage tank(s):</p> <p>The fuel oil in any storage tank (and day tank, if used) shall be tested in accordance with Clause 11.5.5, and if the fuel oil fails the test, it shall be</p> <ul style="list-style-type: none"> <li>(a) drained and refilled with fresh fuel in accordance with Article 6.7.1.5 of the <i>National Fire Code of Canada</i>; or</li> <li>(b) full filtered to remove water, scale, bacteria, and oxidized gums/ resins in order to minimize filter clogging and ensure diesel start-up (see Clause B.20 for commentary).</li> </ul> <p>When the fuel is filtered, it shall be treated with suitable conditioner and stabilizer to minimize degradation while in storage.</p> <p><b>Note:</b> <i>The bottom(s) of the tank(s) shall be also tested chemically for water.</i></p>

(Continued)



**Table 5 (Concluded)**

<p>5. Generator:</p> <ul style="list-style-type: none"><li>(a) Test surge suppressor and rotating rectifier on brushless machines.</li><li>(b) Grease bearings (replace old grease with new) (if applicable).</li><li>(c) Clean commutator and slip rings (if applicable).</li><li>(d) Clean rotor and stator windings using clean compressed air.</li><li>(e) Inspect coupling bolts and alignment.</li><li>(f) Inspect conduits for tightness.</li><li>(g) Inspect windings at rotor and stator slots.</li><li>(h) Inspect all electrical connections.</li><li>(i) With the generator set operating at full load (see Clause 11.3), conduct an infrared survey of all electrical connections to identify and high-resistance connections.</li></ul>
<p>6. Transfer switches:</p> <ul style="list-style-type: none"><li>(a) Isolate transfer switch, open all inspection covers, and inspect all electrical connections.</li><li>(b) Operate all moving parts to ensure that they move freely.</li><li>(c) Clean and dress contacts as required.</li><li>(d) Remove all dust.</li><li>(e) Clean and lubricate linkages.</li><li>(f) Conduct an infrared survey of all electrical connections, contacts, and energized components while under load on both the normal and the emergency side.</li></ul>
<p>7. Lubricate door locks and hinges (if necessary), especially those of outdoor enclosures.</p>
<p>8. Conduct a 2 h full-load test (see Clause 11.3).</p>
<p>9. As needed, review and provide instruction on the technical requirements specified in Tables 2 to 4 with the person(s) responsible for carrying out the work.</p>
<p>10. Correct all the defects found during inspections and tests.</p>
<p>11. Record all inspections, tests, and corrective actions in the log (see Clause 11.5.3).</p>

**Note:** *Item 2 to 11 require special skill and shall be carried out by a qualified contractor, the system manufacturer, or individuals trained and certified by the system manufacturer.*

**Table 6**  
**Quinquennial (every five years) inspection,  
test, and maintenance requirements**  
(see Clauses 11.1.2, 11.5.1, and 11.5.2)

<p>1. Generator:  Inspect insulation of generator windings. Use an insulation tester (megger). The resistance in megohms should be not less than</p> <p style="text-align: center;"><u>Rated voltage + 1000</u>  1000</p> <p>If the resistance is less, dry out the insulations using the auxiliary heat process.</p>
<p>2. Engine:</p> <ul style="list-style-type: none"> <li>(a) Drain and flush the cooling system. Refill the system with new coolant.</li> <li>(b) Clean radiator tubes and cooling fins.</li> <li>(c) Replace thermostats.</li> <li>(d) Inspect valve clearances and adjust as appropriate.</li> </ul>
<p>3. Correct all defects found during inspections and tests.</p>
<p>4. Record all inspections, tests and corrective actions in the log (see Clause 11.5.3).</p>

**Note:** *Items 1 to 4 require special skill and shall be carried out by a qualified contractor, the system manufacturer, or individuals trained and certified by the system manufacturer.*