

PART B-04: DISTRIBUTION SUBSTATIONS

PART B-04

TITLE: DISTRIBUTION SUBSTATIONS

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1. SCOPE

This document provides guidelines for the minimum maintenance requirements of distribution substations. A distribution substation is defined as a part of an electrical system, confined to a given area, including mainly the termination of distribution lines, switchgear, buildings and transformers.

2. INSPECTION, MAINTENANCE, AND TESTING CATEGORIES

The following maintenance strategies are applicable to the maintenance of distribution substations.

- a) **Periodic inspection and maintenance** should be performed to verify proper system operation and general system upkeep.
- b) **Preventative maintenance (PM) and testing** may require removing the equipment from service and performing tests on the equipment or the materials to ensure proper operation. This type of maintenance occurs on a regularly scheduled basis.
- c) **Condition-based maintenance** should be performed following a fault condition, excessive number of operations of equipment or any abnormalities found.

2.1 Periodic inspection and maintenance

Substation monthly inspections and maintenance should consist of the following:

- a) Verify cleanliness of substation, both inside and outside the building should there be a building. Particular attention should be given to combustible rubbish material such as newspapers, drawings and storage of materials not related to substation operations and maintenance in the same room or area.
- b) Check for the presence of oil, dust or other material generated from traction power equipment inside or outside the equipment room or building.
- c) Inspect and replace air filters if necessary
- d) Verify correct operation of any oil/water separators.
- e) Check for presence of water or other material leaking into the substation from elsewhere.
- f) Check for the presence of any “burning” smell, fumes, scorch marks or other material that could be signs of a future breakdown.
- g) Test emergency exit lighting and doors to verify they are fully operational.
- h) Verify operation of all lamps. Replace as necessary.

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- i) Verify operation of all alarms.
- j) Verify operation of heating and ventilation systems.
- k) Verify that voltmeters/ammeters/wattmeters (and battery chargers and inverters if present) give sensible readings. Investigate any unexpected readings.
- l) Record all counter readings and other parameters as required and where available.

3. PREVENTATIVE MAINTENANCE AND TESTING

Preventative maintenance should include all items in Section 3.1 of this document.

3.1 Condition-based maintenance

3.1.1 Post fault conditions

Post-fault conditions are defined as any condition where a system failure occurred that has caused either repetitive faults or lockout trip of any subsystem.

Example: A dc circuit short circuit would require a thorough check of the circuit breaker, distribution system, ground, and associated devices.

3.1.2 Other conditions

- a) Exceeding the recommended number of operations under load conditions for circuit breakers.
- b) Defects encountered during monthly inspections that would generate a priority 1 or 2 as listed in Section 5 of this guideline.
- c) Any abnormal conditions found.

4. PROCEDURES

The Licensee should perform inspection, maintenance, and testing in accordance with this guideline and develop local policies and procedures to meet the requirements herein.

No work should be performed unless proper procedures, documentation, and authorization have been obtained to perform the prescribed task at the designated location. Upon completion of the work, the respective supervisor must be informed that the prescribed task is completed.

4.1 Written policies and procedures

Each Licensee should develop specific written policies and procedures that take into account specific equipment designs and local operating conditions to implement the inspection, maintenance, and testing required by this guideline. These policies and procedures should give maintenance staff clear guidance and criteria for performing these activities.

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4.2 Procedures for inspecting

To monitor the condition of the Substation the following should be done:

4.2.1 *General*

In the absence of an RCM Study, all Substations and major primary equipment within should be **inspected at least** once quarterly.

- a) All defects should be reported immediately to the Licensee's respective supervisor for immediate attention.
- b) All defects found should be recorded and reported through the appropriate channels along with the date and time of the inspection and the name and department of the person who carried out the inspection;
- c) If there are any defects that can be corrected with the equipment in service, immediate action should be taken. E.g. replacement of silica gel.
- d) Pollution levels on all equipment should be visually inspected. An anti-pollution medium should be applied in accordance with local requirements.

4.2.2 *Control room*

- a) All panels should be correctly labelled at the front and back (if applicable);
- b) All panels should be clean and free of dust;
- c) All indication equipment should be working;
- d) All meters (e.g. ammeters, voltmeters) and recorders should be in working order;
- e) All panel-blanking plates should be fitted as required;
- f) Key boxes, where fitted, should be kept locked or sealed;
- g) The latest revision of the substation diagram should be displayed at all times;
- h) All kWh, kVA and kVAh demand indicators should be inspected and readings should be taken;
- i) All protection relays that may have operated should be checked, logged and only reset once reported to the relevant control centre;
- j) NB: Turn the panel light switches to the "off" position after concluding an inspection;
- k) The substation logbook should be in place;
- l) Panels opened should be barricaded;
- m) Control panel labelling should be permanent.

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4.2.3 Medium voltage equipment

4.2.3.1 Outdoor Busbars and structures

- a) Inspect all busbars and structures for discoloration (indicative of overheating), galvanic corrosion, deformation, buckling or cracking. Where corrosion occurs, this should be immediately rectified.
- b) All insulators should be checked for chipped, cracked or broken sheds. A maximum of 20 % of chipped, cracked or broken sheds is permitted on an insulator.
- c) Check all connections for loose, missing or damaged bolts.
- d) Busbar labelling should be legible and correctly installed.
- e) Structure earthing should be intact and properly connected.
- f) Check for bird nests.
- g) Ensure that all equipment that should be locked is locked.
- h) Ensure that all barricading is in place where applicable.

4.2.3.2 Air-break isolators

Air-break isolators should be inspected and maintained in accordance with OEM manuals

4.2.3.3 Circuit-breakers

Circuit-breakers (including indoor switchgear) should be inspected and maintained in accordance with OEM manuals

4.2.3.4 Instrument transformers

- a) Insulators should be inspected for chips or breakage. A maximum of 20% of chipped, cracked or broken sheds is permitted on an insulator;
- b) There should be no insulating oil leaks or SF6 leaks (check SF6 pressure gauge). If any leaks are found these should be repaired by authorized personnel only.
- c) All oil levels should be correct;
- d) All gauge glasses should be clean and clear;
- e) Terminal box covers should be secured in position. Wire should not be used to secure the covers;
- f) All metal work should be checked for corrosion and rust; and
- g) Earth straps should be in good condition and should be effectively connected.

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4.2.3.5 Capacitor banks

Note: Do not enter a capacitor bank enclosure when the capacitor bank is live.

Capacitor bank maintenance should be carried out in accordance with OEM manuals and/or in compliance with applicable standards.

- a) Externally fused capacitors should be inspected for blown fuses;
- b) Insulators should be inspected for chips, cracks or broken sheds. A maximum of 20 % of chipped, cracked or broken sheds is permitted on an insulator;
- c) Capacitor cans should be checked for insulating fluid leaks;
- d) The fence and gate should be checked to ensure that they are properly secured, in a good state, free of rust and effectively earthed. The gate should be locked at all times with the appropriate type of lock;
- e) All notices and labels should be securely fixed and legible;
- f) Earth straps should be in a good condition and should be effectively connected; and
- g) An earthing procedure for each specific unit should be available at each site for earthing purposes.

4.3 General conditions

4.2.2 General

All fences and gates should be properly secured, in good mechanical condition and they should comply with applicable earthing standards.

- a) All statutory notices and signs should be clearly displayed
- b) All buildings, doors, windows and paintwork should be in a good condition;
- c) All MV yards should be free of weeds and clear of loose wires, debris and unused equipment;
- d) All telephones and radios should be in working order and emergency telephone numbers should be displayed next to the telephone;
- e) All trench covers should be in place and free of damage;
- f) Yards should be free of silts and water pooling after rain;
- g) Floodlighting should be checked to ensure that all lights are working. If fitted with day/night switches, the functioning of the day/night switch should also be verified;
- h) Stand-by generators should be run-up in accordance with the relevant procedures;

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- i) All indoor lights and emergency lights should be in working order;
- j) Access roads should be properly maintained.
- k) Any excessive audible noise i.e. transformer vibration or arcing of substation equipment should be reported to the responsible person;

4.2.3 Reporting and recording

All substations should have a log book and inspection sheet. All work done by any person at the substation should be recorded. An example of such a sheet is shown in **Annex A**.

The following should be recorded, as a minimum, into CMMS (Computerized maintenance management system) after each inspection:

- a) Present and maximum loading of all panels in amperes;
- b) All relays that may have operated since the substation was last visited;
- c) All fault trips;
- d) All oil levels, SF6 and air pressures;
- e) Present and maximum oil and winding temperatures of all transformers;
- f) All breaker counter readings. Concerning breakers with panel and mechbox meter, the mechbox meter reading should be recorded.
- g) Tap-change operations, if applicable;
- h) All checks undertaken such as;
 - 1) Lighting;
 - 2) Stand-by generator,
 - 3) Cooling fans and oil pumps.
- i) The condition of silica gel and the oil dashpot on all breathers;
- j) All defects found should be noted and reported to the appropriate supervisor;
- k) Date and time of the inspection and the name of the person who carried out the inspection.

5 PRIORITY RATINGS

The licensee should develop a priority rating system to evaluate and determine the effects that any single defect will have on the network if they choose to operate with a known defect.

Recommended priority ratings are:

Priority 1: The defect will endanger the safety of personnel and/or continuation of revenue service. A permanent or temporary repair should be made immediately.

Priority 2: The defect may cause disruption of revenue service. The repair should be made in a predetermined timeframe set by each system.

Priority 3: The defect will not affect revenue service. The repair should be made in a predetermined timeframe set by each system.

6 DOCUMENTATION

The Licensee should develop and implement a fully auditable process for recording and tracking inspection, maintenance, and testing activities and outstanding system defects. Such documentation should be documented, reviewed, and filed in accordance with electricity distributor's procedures and the equipment manufacturer's recommendations. Documentation should be kept for the life of all in-service equipment.

Annex A

A.1 Informative

Recommended Inspection Intervals for Substations

The following are guidelines and recommended intervals for the various maintenance inspections to be carried out on Substations

Item/Equipment	Interval	Activity
Substations	Quarterly	Inspection and cleaning
substation Cleaning (surroundings)	Quarterly	Inspection and cleaning
Batteries	monthly	inspection
Security Systems	monthly	inspection
Workshop equipment	monthly	Safety checks
Air-conditioning	monthly	check and clean filters
Mini Substations	Quarterly	Inspection and cleaning
Substation surroundings	Quarterly	Cleaning and cutting of grass
Filter Plant	Quarterly	Check and maintain
Workshop equipment	Quarterly	Check and maintain

**GUIDE TO MAINTENANCE PRACTICES FOR DISTRIBUTION NETWORKS IN THE DISTRIBUTION SECTOR OF
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Neutral Resistors	half yearly	Inspect tanks and check valves
Outdoor substation yard	half yearly	Infrared scan. Insulator washing
Motorized Isolators	half yearly	Check and maintain
Substations	Annually	Fire extinguishers overhaul.
Transformers	Annually	oil tests
On Load Tap Changer	2 yearly	Overhaul
Substation Buildings	5 yearly	Paint and maintain
Outdoor transformers	5 yearly	Paint and maintain
Open Substation Yards	5 yearly	Paint and maintain
Batteries	5 yearly	Clean and overhaul
Substations	10 Yearly	Clean and overhaul

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Annex B

(Informative)

B.1 Documentation

Each substation should have a logbook or CMMS containing the following transformer information:

Transformers:

- a) Make
- b) Type
- c) Serial No
- d) Vector Group
- e) MVA
- f) Voltage Ratio (MV/LV)
- g) Rated full load amps (MV/LV)
- h) % impedance

The following should be recorded in the substation logbook at each inspection:

- a) Present winding temperatures, where applicable
- b) Maximum winding temperatures, where applicable
- c) Present LV load in amps, where applicable
- d) Maximum LV load in amps
- e) All oil levels (Main and conservator)
- f) Condition of silica gel and oil dashpot
- g) Working condition of the cooling fans, where applicable
- h) Any defects or abnormalities found and details of repairs
- i) Date and time of the inspection
- j) The name of the person who carried out the inspection

Ring main units:

- a) All oil levels
- b) SF6 pressure level
- c) Earth fault indicator
- d) Any defects or abnormalities found and details of repairs
- e) Date and time of the inspection and
- f) The name of the person who carried out the inspection

B.2 Training

The maintenance staff should have adequate training and competence to perform required tasks safely.