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Substation Maintenance Instruction

Capacitors

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Substation Maintenance Instruction

ASSET STANDARDS AND DESIGN

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SMI209 CAPACITORS

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1.0 PURPOSE

To set out in detail the standard for maintaining capacitor banks installed in Endeavour Energy's zone and transmission substations.

2.0 SCOPE

This instruction is to be read in conjunction with Substation Maintenance Instruction SMI 100 – Minimum requirements for maintenance of transmission and zone substation equipment.

This standard outlines the broad maintenance requirements for capacitors and associated isolator and earthing switches in Endeavour Energy's zone and transmission substations. This includes outdoor as well as enclosed and indoor capacitor banks.

The maintenance requirements of other associated equipment that are not covered within this instruction are outlined in following standards:

- De-tuning or inrush reactors – SMI 154;
- Circuit breakers – SMI 200 ; and
- Surge arresters – SMI108.

3.0 REFERENCES

Internal

- Company Policy 9.9.1 – Network Asset Maintenance
- Company Procedure GSY 1066 – Worksite Hazard and Risk Assessment
- Company Form FSY 0118 – Worksite Coordination/Hazard and Risk Assessment
- Division Procedure GNV 1094.5 – Testing of network equipment: Withstand testing
- PMI 4120- Maintenance of Protection
- SMI 100 – Minimum requirements for maintenance of transmission and zone substation equipment
- SMI 108 – Miscellaneous substation equipment
- SMI 119 – Transmission and zone substation data entry, asset structure and nameplate details
- SMI 124 – Maintenance data entry and defect prioritisation
- SMI 154 – Reactors
- SMI 200 – HV Circuit breakers

External

Electricity Supply Act 1995 (as amended)

Work Health and Safety Act 2011 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2014 (NSW)

Work Health and Safety Regulation 2011

ENA National Electricity Network Safety Code (Doc 01-2008)

AS 5577 – 2013 – Electricity network safety management systems

IEC 60871-1:2014 Shunt capacitors for a.c. power systems having a rated voltage above 1000V - Part 1: General

4.0 DEFINITIONS AND ABBREVIATIONS

Ellipse

Endeavour Energy's asset management database

SMI

Substation Maintenance Instruction

PMI

Protection Maintenance Instruction

5.0 ACTIONS**5.1 General**

The routine maintenance of capacitors is based on IEC 60871, manufacturer's recommendations and industry best practice. Where available, all work is to be carried out in accordance with the manufacturer's instructions.

Prior to commencing maintenance work, capacitors must be short-circuited, earthed and completely discharged. The minimum discharge time must be as per the manufacturer's recommendation.

All defects and abnormalities found during routine maintenance are to be recorded in Ellipse.

Due to the age of some equipment on the network, it is required that, for the particular item on which the maintenance work is being carried out, the nameplate data that has been recorded in Ellipse must be confirmed, and all nameplate data that has not yet been recorded in Ellipse must be captured in accordance with requirement SMI 119 and entered into asset management database.

5.2 Routine Maintenance Requirements

Distinct types or brands of capacitor units may not contain some of the components listed for routine maintenance, in which case that particular component is to be disregarded.

The set of maintenance requirements for capacitor banks is outlined in the maintenance schedule provided in Annexure 1 of this instruction.

6.0 AUTHORITIES AND RESPONSIBILITIES

Manager Asset Standards & Design has the authority and responsibility for approving the amendments to this Standard in accordance with GAM0001.

Substation Assets Manager has the authority and responsibility for keeping the content of this Standard up to date.

All Regional Transmission Managers have the authority and responsibility for:

- checking that the requirements of this instruction and data entry requirements are met when recording information in the equipment register;
- checking that Endeavour Energy employees and/or contractors engaged to perform the work and have appropriate qualifications and are competent to carry out the work;
- providing appropriate equipment and training;
- analysing the test results equipment when test reports are received; and
- identifying potential problems with equipment and taking appropriate action.

Endeavour Energy employees and/or contractors have the authority and responsibility for:

- meeting the requirements of this instruction;
- working in accordance with Endeavour Energy's Electrical Safety Rules;
- updating the Endeavour Energy's asset database; and
- communicating abnormalities found in data to the Regional Transmission Managers and Substation Assets Manager.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Substation Assets Manager

Documentation Distribution Coordinator : Branch Process Coordinator

Annexure 1: Maintenance Schedules Of Capacitor Banks

A. VISUAL-IN-SERVICE INSPECTION

ROUTINE MAINTENANCE SCHEDULE	
Visual In-service inspection: ABB ABBACUS 11kV Capacitor Bank (Enclosed)	
1.1	Visually inspect the equipment in general, check and note any defects.
1.2	Inspect for weeds.
1.3	Check labels/signs are legible and correctly fitted.
1.4	Inspect enclosure for corrosion or other defects.
1.5	Inspect condition of door locks.
1.6	Inspect condition of forced ventilation filter pad, replace when found dirty.
1.7	Capture the nameplate data that has not been recorded or incorrectly entered in Ellipse and update accordingly.

ROUTINE MAINTENANCE SCHEDULE	
Visual In-service inspection: Amp Control 11kV Capacitor Bank (Enclosed And Indoor)	
1.1	Visually inspect the equipment in general, check and note any defects.
1.2	Inspect for weeds.
1.3	Check labels/signs are legible and correctly fitted.
1.4	Inspect enclosure for corrosion or other defects.
1.5	Inspect condition of door locks.
1.6	Capture the nameplate data that has not been recorded or incorrectly entered in Ellipse and update accordingly.

ROUTINE MAINTENANCE SCHEDULE	
Visual-In-service inspection : All Outdoor Capacitor Banks	
1.1	Visually inspect the equipment in general, check and note any defects.
1.2	Inspect tank for oil leaks, spillage, corrosion, poor paintwork condition or other defects.
1.3	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.4	Inspect bushings/cable sealing ends for cracks, treeing, tracking, visible effects of corona or other defects.
1.5	Inspect for weeds.
1.6	Check labels/signs are legible and correctly fitted.
1.7	Inspect steelwork/hardware for corrosion or other defects.
1.8	Inspect gate, locks on gate and fence condition.
1.9	Capture the nameplate data that has not been recorded or incorrectly entered in Ellipse and update accordingly.

B. MINOR OVERHAUL

ROUTINE MAINTENANCE SCHEDULE	
Minor Overhaul: ABB ABBACUS 11kV Capacitor Bank (Enclosed)	
1.1	Visually inspect the equipment in general, check and note any defects.
1.2	Inspect for weeds and spray weeds with non-residual weed killer, as required.
1.3	Check labels/signs are legible and correctly fitted.
1.4	Inspect enclosure for corrosion or other defects.
1.5	Inspect condition of door locks.
1.6	Capture the nameplate data that has not been recorded or incorrectly entered in Ellipse and update accordingly.
1.7	Inspect ceiling for any water ingress and steelwork/hardware for corrosion or other defects.
1.8	Check that all equipment ventilation is free from debris.
1.9	Inspect condition of forced ventilation filter pad, replace when found dirty.
1.10	Where applicable, check that the forced ventilation fans and associated thermostats are operational. Set thermostat to 35°C.
1.11	Where applicable, check that the heaters and associated thermostats are operational. Set thermostat to 15°C.
1.12	Inspect tank for oil leaks, spillage, corrosion, poor paintwork condition or other defects.
1.13	Inspect bushings/cable sealing ends for cracks, treeing, tracking, visible effects of corona or other defects.
1.14	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.15	Clean all parts and remove dust deposits.
1.16	Check tightness of all HV electrical connections.
1.17	Check all secondary wiring terminations.
1.18	Check the operation of the HV contactors.
1.19	Check the operation of the HV circuit breaker.
1.20	Check ancillary devices, such as lights, are of sound condition and operational.
1.21	Repeat oil leak, filter pad and ventilation check.
1.22	Inspect for any defects.

ROUTINE MAINTENANCE SCHEDULE	
Minor Overhaul: Amp Control 11kV Capacitor Bank (Enclosed And Indoor)	
1.1	Visually inspect the equipment in general, check and note any defects.
1.2	Inspect for weeds and spray weeds with non-residual weed killer, as required.
1.3	Check labels/signs are legible and correctly fitted.
1.4	Inspect enclosure for corrosion or other defects.
1.5	Inspect condition of door locks.
1.6	Capture the nameplate data that has not been recorded or incorrectly entered in Ellipse and update accordingly.
1.7	Check that viewing windows are adequately clear (only for enclosed units)
1.8	Inspect ceiling for any water ingress and steelwork/hardware for corrosion or other defects (only for enclosed units)
1.9	Inspect tank for oil leaks, spillage, corrosion, poor paintwork condition or other defects.
1.10	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.11	Inspect bushings/cable sealing ends for cracks, treeing, tracking, visible effects of corona or other defects.
1.12	Clean all parts and remove dust deposits.
1.13	Check tightness of all HV electrical connections.
1.14	Check all secondary wiring terminations.
1.15	Check that all equipment ventilation is free from debris.
1.16	Where applicable, check that the forced ventilation fans and associated thermostats are free from debris and are operational. Set thermostat to 35°C.
1.17	Check the operation of the HV contactors.
1.18	Check the operation of the HV circuit breaker.
1.19	Check ancillary devices, such as lights, are of sound condition and operational.
1.20	Repeat oil leak and ventilation check.
1.21	Check tightness of primary, secondary and earthing connections.
1.22	Inspect for any defects

C. MAJOR OVERHAUL

ROUTINE MAINTENANCE SCHEDULE		
Major Overhaul : ABB ABBACUS 11kV Capacitor Bank (Enclosed)		
1.1	Visually inspect the equipment in general, check and note any defects.	
1.2	Inspect for weeds and spray weeds with non-residual weed killer, as required.	
1.3	Check labels/signs are legible and correctly fitted.	
1.4	Inspect enclosure for corrosion or other defects.	
1.5	Inspect condition of door locks.	
1.6	Inspect ceiling for any water ingress and steelwork/hardware for corrosion or other defects.	
1.7	Check that all equipment ventilation is free from debris.	
1.8	Inspect condition of forced ventilation filter pad, replace when found dirty.	
1.9	Where applicable, check that the forced ventilation fans and associated thermostats are operational. Set thermostat to 35°C.	
1.10	Where applicable, check that the heaters and associated thermostats are operational. Set thermostat to 15°C.	
1.11	Check for any blown fuses and note whether the fuse has blown electrically or failed mechanically.	
1.12	Inspect tank for distortion. Only to be carried out if fuse has blown electrically or protection unbalance relay trips.	
1.13	Inspect tank for oil leaks, spillage, corrosion, poor paintwork condition or other defects.	
1.14	Tap the highest point of the can with a metal object and determine if there is a hollow sound, indicating a gas pocket. Replace if gas pocket is indicated. <i>Only to be carried out if fuse has blown electrically or protection unbalance relay trips.</i>	
1.15	Inspect bushings/cable sealing ends for cracks, treeing, tracking, visible effects of corona or other defects.	
1.16	Clean all parts and remove dust deposits.	
1.17	Inspect HV terminations for corrosion, burning, overheating or other defects.	
1.18	Check tightness of all HV electrical connections.	
1.19	Check all secondary wiring terminations.	
1.20	Check the operation of the HV contactors.	
1.21	Check the operation of the HV circuit breaker.	
1.22	Check operation of earthing and shorting switches.	
1.23	Lubricate earthing and shorting switches with suitable weatherproof grease.	
1.24	Check ancillary devices, such as lights, are of sound condition and operational.	
1.25	Measure the main circuit resistance, before and after maintenance : Terminal to terminal on the contactor	Pass Criteria: < 140 micro Ohms @ 100A
1.26	Measure the main circuit resistance, before and after maintenance : Terminal to terminal on the Isolator/earth switch at earth cubicle:	Pass Criteria: < 120 micro Ohms @ 100A
1.27	Measure the main circuit resistance, before and after maintenance : Terminal to terminal on the circuit breaker:	Pass Criteria: < 90 micro Ohms @ 100A
1.28	Check the vacuum integrity of HV circuit breaker using VIDAR.	Pass Criteria: Green indication on VIDAR test device (Test procedure as per GNV 1094.5)

1.29	Check the vacuum integrity of HV contactors using VIDAR.	Pass Criteria: Green indication on VIDAR test device (Test procedure as per GNV 1094.5)
1.30	Measure capacitance and record values (refer section 5.3 for recording individual capacitance measured values). Balance phase capacitances as required. Check the unit's capacitance with the nameplate value.	Pass Criteria: ±10% of Nameplate Value
1.31	The difference in ratio of the capacitances of any two (2) units forming part of a capacitor stack shall be	Pass Criteria: < 5 % of reciprocal ratio of the rated voltages of the units.
1.32	Repeat operational check for HV contactor, HV CB after diagnostic testing.	
1.33	Repeat oil leak, filter pad, heater and ventilation check.	
1.34	Check tightness of primary, secondary and earthing connections.	

ROUTINE MAINTENANCE SCHEDULE		
MAJOR OVERHAUL : Amp Control 11kv Capacitor Bank (Enclosed And Indoor)		
1.1	Visually inspect the equipment in general, check and note any defects.	
1.2	Inspect for weeds and spray weeds with non-residual weed killer, as required.	
1.3	Check labels/signs are legible and correctly fitted.	
1.4	Inspect enclosure for corrosion or other defects.	
1.5	Inspect condition of door locks.	
1.6	Capture the nameplate data that has not been recorded or incorrectly entered in Ellipse and update accordingly.	
1.7	Check that viewing windows are adequately clear (only for enclosed units)	
1.8	Inspect ceiling for any water ingress and steelwork/hardware for corrosion or other defects (only for enclosed units)	
1.9	Check for any blown fuses and note whether the fuse has blown electrically or failed mechanically.	
1.10	Tap the highest point of the can with a metal object and determine if there is a hollow sound, indicating a gas pocket. Replace if gas pocket is indicated. <i>Only to be carried out if fuse has blown electrically or protection unbalance relay trips.</i>	
1.11	Inspect tank for distortion. Only to be carried out if fuse has blown electrically or protection unbalance relay trips. (Relay testing By P&C).	
1.12	Inspect tank for oil leaks, spillage, corrosion, poor paintwork condition or other defects.	
1.13	Inspect HV terminations for corrosion, burning, overheating or other defects.	
1.14	Inspect bushings/cable sealing ends for cracks, treeing, tracking, visible effects of corona or other defects.	
1.15	Clean all parts and remove dust deposits.	
1.16	Check tightness of all HV electrical connections.	
1.17	Check all secondary wiring terminations.	
1.18	Check that all equipment ventilation is free from debris.	
1.19	Where applicable, check that the forced ventilation fans and thermostats are free from debris and are operational. Set thermostat to 35°C.	
1.20	Check the operation of the HV contactors. Check contactor operation before and after maintenance.	
1.21	Check the operation of the HV circuit breaker.	

1.22	Lubricate earthing and shorting switches with suitable weatherproof grease.	
1.23	Check operation of earthing and shorting switches.	
1.24	Check ancillary devices, such as lights, are of sound condition and operational.	
1.25	Measure the main circuit resistance, before and after maintenance : Terminal to terminal on the contactor	Pass Criteria: < 120 micro Ohms @ 100A
1.26	Measure the main circuit resistance, before and after maintenance : Terminal to terminal on the Isolator/earth switch at earth cubicle:	Pass Criteria: < 90/500 micro Ohms @ 100A
1.27	Measure the main circuit resistance, before and after maintenance : Terminal to terminal on the circuit breaker:	Pass Criteria: < 90 micro Ohms @ 100A
1.28	Measure the main circuit resistance, before and after maintenance : Terminal to terminal on the earth switch:	Pass Criteria: < 90 micro Ohms @ 100A
1.29	Measure capacitance and record values (refer section 5.3 for recording individual capacitance measured values). Balance phase capacitances as required. Check the unit's capacitance with the nameplate value.	Pass Criteria: ±10% of Nameplate Value
1.30	The difference in ratio of the capacitances of any two (2) units forming part of a capacitor stack shall be	Pass Criteria: < 5 % of reciprocal ratio of the rated voltages of the units.
1.31	Check the vacuum integrity of HV circuit breaker using VIDAR.	Pass Criteria: Green indication on VIDAR test device (Test procedure as per GNV 1094.5)
1.32	Check the vacuum integrity of HV contactors using VIDAR.	Pass Criteria: Green indication on VIDAR test device (Test procedure as per GNV 1094.5)
1.33	Repeat oil leak and ventilation check.	
1.34	Check tightness of primary, secondary and earthing connections.	
1.35	Inspect for any defects.	

ROUTINE MAINTENANCE SCHEDULE	
MAJOR OVERHAUL : All Outdoor Capacitor Banks	
1.0	Visually inspect the equipment in general, check and note any defects.
1.1	Inspect for weeds and spray weeds with non-residual weed killer, as required.
1.2	Inspect gate, locks on gate and fence condition.
1.3	Inspect steelwork/hardware for corrosion or other defects.
1.4	Check labels/signs are legible and correctly fitted.
1.5	Capture the nameplate data that has not been recorded or incorrectly entered in Ellipse and update accordingly.
1.6	Check for any blown fuses and note whether the fuse has blown electrically or failed mechanically.
1.7	Tap the highest point of the can with a metal object and determine if there is a hollow sound, indicating a gas pocket. Replace if gas pocket is indicated. Only to be carried out if fuse has blown electrically or protection unbalance relay trips.
1.8	Inspect tank for distortion. Only to be carried out if fuse has blown electrically or protection unbalance relay trips.
1.9	Inspect tank for oil leaks, spillage, corrosion, poor paintwork condition or other defects.

1.10	Inspect HV terminations for corrosion, burning, overheating or other defects.	
1.11	Inspect bushings/cable sealing ends for cracks, treeing, tracking, visible effects of corona or other defects.	
1.12	Clean all parts as required.	
1.13	Lubricate earthing and shorting switches with suitable weatherproof grease.	
1.14	Check operation of earthing and shorting switches.	
1.15	Measure capacitance and record values (refer section 5.3 for recording individual capacitance measured values). Balance phase capacitances as required. Check the unit's capacitance with the nameplate value.	Pass Criteria: -5 to +10% of Nameplate Value
1.16	The difference in ratio of the capacitances of any two (2) units forming part of a capacitor stack shall be:	Pass Criteria: < 5 % of reciprocal ratio of the rated voltages of the units.
1.17	Repeat oil leak check (for oil filled reactors).	
1.18	Check tightness of primary, secondary and earthing connections.	
1.19	Inspect for any defects.	