

Substation Maintenance Instruction

Current transformers

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SUBSTATION MAINTENANCE INSTRUCTION

ASSET STANDARDS & DESIGN

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SMI 158 CURRENT TRANSFORMERS

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1.0 PURPOSE

To set out in detail the broad maintenance requirements for post current transformers installed in transmission and zone substations.

2.0 SCOPE

This instruction **must** be read in conjunction with **Substation Maintenance Instruction SMI100** – Minimum requirements for maintenance of transmission and zone substation equipment.

The detailed maintenance procedures are the responsibility of the Regional Transmission Manager.

All work **must** be carried out in accordance with manufacturers' recommendations. If test results are outside these limits, the **Substation Assets Manager** **must** be consulted prior to returning asset to service.

3.0 REFERENCES

Internal

Group Board Policy (Governance) 2.0.5 – Risk Management
Group Board Policy (Health & Safety) 3.0 – Work Health and Safety
Group Board Policy (Environment) 4.0 – Environment
Company Policy (Network) 9.1.10 – Network Electrical Safety
Company Policy (Network) 9.9.1 – Network Asset Maintenance
Company Procedure (Health & Safety) GSY 0003 – Hazardous Manual Tasks
Company Procedure (Health & Safety) GSY 0067 – Personal Protective Equipment
Company Form (Health & Safety) FSY 0118 – Worksite Coordination/Hazard and Risk Assessment
Substation Maintenance Instruction SMI 100 – Minimum requirements for maintenance of transmission and zone substation equipment
Substation Maintenance Instruction SMI 103 – Testing of in-service insulating oil
Substation Maintenance Instruction SMI 124 – Maintenance data entry and defect prioritisation
Substation Maintenance Instruction SMI 119 – Transmission and zone substation data asset structure and nameplate details
Substation Maintenance Instruction SMI 156 – Breathers
Environmental Management Standard EMS 0001 - Environmental impact assessment and environmental management plans
Environmental Management Standard EMS 0008 - Environment incident response and management
Endeavour Energy Network Management Plan
Endeavour Energy Electrical Safety Rules
Annexure 1 – Maintenance Schedules of Current Transformers

External

Electricity Supply Act 1995 (NSW)
Electricity Supply (Safety and Network Management) Regulation 2014
Work Health and Safety Act 2011 (NSW)
Work Health and Safety Regulation 2017 (NSW)
AS 5577 – 2013 – Electricity network safety management systems
ENA National Electricity Network Safety Code (Doc 01-2008)
National Electricity (NSW) Law 1997
National Electricity Rules
AS 2467:2008 - Maintenance of electrical switchgear
AS 3000:2007 - Electrical installations (Wiring Rules)

AS 60044.1-2007 - Instrument transformers - Current transformers
AS/NZS 60137:2008 - Insulated bushings for alternating voltages above 1000V
Procedures for Risk Management in Electricity Distribution Industry - EC2 - December 1991
AS 1767.2.2-2008 - Insulating liquids - Test methods - Measurement of relative permittivity, dielectric dissipation factor ($\tan \delta$) and d.c. resistivity

4.0 DEFINITIONS AND ABBREVIATIONS

Current transformer (CT) ¹

An instrument transformer in which the secondary current, in normal condition of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections.

Content Server

Endeavour Energy document management system

Dielectric dissipation factor - DDF ($\tan \delta$) ²

Dielectric dissipation factor, DDF, ($\tan \delta$) of an insulating material is the tangent of the loss angle. The loss angle is the angle by which the phase difference between applied voltage and the resulting current deviates from $\pi/2$ rad when the dielectric of the capacitor consists exclusively of the insulating material.

Ellipse

Endeavour Energy's asset database.

Material Safety Data Sheet (MSDS)

Information on ingredients, physical data, fire and explosion data, transportation, reactivity, environmental and disposal, health hazards, first aid, handling precautions and any other additional information needed for the safe handling and use of materials.

Test tap ³

Also known as measuring tap and $\tan \delta$ tap connection, accessible from outside the bushing, insulated from the flange or other fixing device, made to one of the outer conducting layers of a capacitance graded bushing in order to allow measurements of dissipation factor, capacitance and partial discharge whilst the flange of the bushing is earthed.

Note 1: This connection should be earthed directly when it is not used.

Note 2: When the test tap is used for condition monitoring, in service, care should be taken to avoid an open circuit.

5.0 ACTIONS

5.1 General

Distinct types or brands of current transformers may not contain some of the components listed for routine maintenance, in which case that particular component **will** be disregarded.

All defects and abnormalities found during routine maintenance **must 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

¹ AS 60044.1: 2007 - Instrument Transformers - Current Transformers

² AS 1767.2.2-2008 - Insulating liquids - Test methods - Measurement of relative permittivity, dielectric dissipation factor ($\tan \delta$) and d.c. resistivity

³ AS/NZS 60137:2008 - Insulated bushings for alternating voltages above 1000V

Ellipse must be confirmed, and all nameplate data that has not yet been recorded in Ellipse must be captured and entered into Ellipse.

5.2 Maintenance schedules

Routine maintenance must always be carried out in accordance with manufacturers' recommendations unless otherwise specified.

Annexure 1 – Maintenance Schedules of Current Transformers, details the routine maintenance schedules, where applicable, the set of maintenance requirements for current transformers in the maintenance schedules given must be met.

Non-routine maintenance schedule tests to prove the integrity of a post current transformer is also given in Annexure 1 – Maintenance Schedules of Current Transformers. At least one of these tests must be carried out only if a post current transformer is suspect and/or under investigation, for example, type faults, oil leaks, unusual noise, and the like.

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:

- Confirming that Endeavour Energy employees and/or contractors engaged to perform the work have appropriate qualifications and are competent to carry out the work.
- Identifying potential problems with equipment when test reports are received.
- Working in accordance with local and statutory requirements.
- Maintaining a high level of public safety.
- Confirming that employees are conversant with and work in accordance with the principles of Endeavour Energy's Electrical Safety Rules.
- Analysing test results to identify potential problems, and taking appropriate action.

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

- Confirming that the requirements of this instruction are met.
- Working in accordance with local and statutory requirements.
- Maintaining a high level of public safety.
- Working in accordance with Endeavour Energy's Electrical Safety Rules.
- Updating the Ellipse database.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Substation Assets Manager

Documentation Distribution Coordinator : Branch Process Coordinator

Annexure 1 – Maintenance Schedules of Current Transformers

Oil filled Current Transformers

ROUTINE MAINTENANCE SCHEDULE		
INSPECTION		
1	Visually inspect the equipment, check and report any defects:	
1.1	Check oil level.	
1.2	Inspect for rust, corrosion, poor paintwork condition or other defects.	
1.3	Inspect cable box seals.	
1.4	Inspect for oil leaks. Note: If a major leak is detected, check that there is sufficient oil in the CT. If oil needs to be topped up, new transformer oil must be used. Care should be taken that no air bubbles or moisture enter the tank.	
1.5	Carry out breather inspection in accordance with SMI 156 (if a breather is fitted).	
1.6	Inspect bushings for treeing, tracking, visible effects of corona, cracks or other defects.	
1.7	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.	
1.8	Confirm that labels/signs are legible and correctly fitted.	
MINOR OVERHAUL		
1	Carry out all tasks set out in the Inspection.	
2	As found checks:	
2.1	Confirm the nameplate data recorded in Ellipse and/or capture the nameplate data that has not been recorded.	
2.2	Check tank head pressure where possible.	
2.3	Check tightness of primary, secondary and earthing connections.	
2.4	Inspect primary, secondary and earthing connections for discolouration or damage.	
3	Minor Overhaul:	
3.1	Clean bushings with recommended solvent.	
3.2	Carry out breather maintenance in accordance with SMI 156 (if a breather is fitted).	
4	Electrical tests: Note 1: If test results are outside these limits, the Substation Assets Manager must be consulted for further investigation prior to returning asset to service. Note 2: No secondary wiring is to be temporarily disconnected during testing without performing in-service checks afterwards, with the exception of earthing connections necessary for testing.	
4.1	Report ambient temperature and humidity during testing.	
4.2	<u>Insulation resistance tests (Primary):</u> Report the insulation resistance at 5.0kV DC for 1 minute between the primary winding to secondary winding and earth. Report the insulation resistance at 5.0kV DC for 1 minute between the primary winding to top metal cap (for oil filled post CTs that are equipped with top oil and/or gas filled tank with metal encasement). Note: Prior to carrying out the IR test between primary winding to top cap, make sure to unbolt the shorting link between the top cap and primary terminal.	<u>Test limit:</u> > 0.5 GΩ

4.3	<u>Insulation resistance test (Secondary):</u> Report the insulation resistance at 500V DC ⁴ for 1 minute between the secondary winding to primary winding and earth.	<u>Test limit:</u> ≥ 1 MΩ ⁵
4.4	<u>Dielectric dissipation factor test:</u> CTs with electrostatically graded (condensor) bushings, and fitted with DDF test tap, must be tested for the bushing dielectric dissipation factor at 2.5kV AC for oil/paper/resin high voltage insulation systems.	<u>Test limits (corrected to 20°C):</u> Oil impregnated paper ≤ 7 mrad Resin impregnated paper ≤ 7 mrad Resin bounded paper ≤ 15 mrad Cast or moulded resin ≤ 15 mrad
5	Final checks:	
5.1	Repeat oil level check.	
5.2	Check tightness of primary, secondary and earthing connections.	
5.3	Inspect for any defects.	
NON-ROUTINE MAINTENANCE SCHEDULE		
INTEGRITY TESTING (FURTHER INVESTIGATION)		
<u>Partial discharge test (11kV ≤ CT rated voltage ≤132kV)⁶:</u> Perform partial discharge tests to AS 60044.1 or as recommended by the manufacturer. Test voltage (r.m.s) = 1.2 x highest voltage (U _m) /√3 (phase to earth)		
<u>Oil samples – Dissolved gas analysis:</u> Take oil sample and test in accordance with SMI103. Test results must be entered into Endeavour Energy's database. Note: Check that there is sufficient oil in the CT. If oil needs to be topped up, new transformer oil must be used. Care should be taken that no air bubbles or moisture enter the tank.		

⁴ AS 2467:2008 - Maintenance of electrical switchgear⁵ AS 3000:2007 - Electrical installations (Wiring rules)⁶ AS 2467:2008 - Maintenance of Electrical Switchgear

Epoxy filled Current Transformers

ROUTINE MAINTENANCE SCHEDULE		
INSPECTION		
1	Visually inspect the equipment, check and report any defects:	
1.1	Inspect for rust, corrosion, poor paintwork condition or other defects.	
1.2	Inspect cable box seals.	
1.3	Inspect bushings for treeing, tracking, visible effects of corona, cracks or other defects.	
1.4	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.	
1.5	Confirm that labels/signs are legible and correctly fitted.	
MINOR OVERHAUL		
1	Carry out all tasks set out in the Inspection.	
2	As found checks:	
2.1	Confirm the nameplate data recorded in Ellipse and/or capture the nameplate data that has not been recorded.	
2.2	Inspect primary, secondary and earthing connections for discolouration or damage.	
2.3	Check tightness of primary, secondary and earthing connections.	
3	Minor Overhaul:	
3.1	Clean bushings with recommended solvent.	
4	Electrical tests: <i>Note 1: If test results are outside these limits, the Substation Assets Manager must be consulted for further investigation prior to returning asset to service.</i> <i>Note 2: No secondary wiring is to be temporarily disconnected during testing without performing in-service checks afterwards, with the exception of earthing connections necessary for testing.</i>	
4.1	Report ambient temperature and humidity during testing.	
4.2	Insulation resistance test (Primary): Report the insulation resistance at 5.0kV DC for 1 minute between the primary winding to secondary winding and earth.	Test limit: > 0.5 GΩ
4.3	Insulation resistance test (Secondary): Report the insulation resistance at 500V DC ⁷ for 1 minute between the secondary winding to primary winding and earth.	Test limit: ≥ 1 MΩ ⁸
4.4	Dielectric dissipation factor test: CTs with electrostatically graded (condensor) bushings, and fitted with DDF test tap, must be tested for the bushing dielectric dissipation factor at 2.5kV AC for oil/paper/resin high voltage insulation systems.	Test limits (corrected to 20°C): Oil impregnated paper ≤ 7 mrad Resin impregnated paper ≤ 7 mrad Resin bounded paper ≤ 15 mrad Cast or moulded resin ≤ 15 mrad
5	Final checks:	
5.1	Repeat oil level check.	
5.2	Check tightness of primary, secondary and earthing connections.	
5.3	Inspect for any defects.	

⁷ AS 2467:2008 - Maintenance of electrical switchgear

⁸ AS 3000:2007 - Electrical installations (Wiring rules)

NON-ROUTINE MAINTENANCE SCHEDULE**INTEGRITY TESTING (FURTHER INVESTIGATION)**

Partial discharge test ($11\text{kV} \leq \text{CT rated voltage} \leq 132\text{kV}$)⁹

Perform partial discharge tests to AS 60044.1 or as recommended by the manufacturer.

Test voltage (r.m.s) = $1.2 \times \text{highest voltage } (U_m) / \sqrt{3}$ (phase to earth)

⁹ AS 2467:2008 - Maintenance of Electrical Switchgear