

Substation Maintenance Instruction

On-load tap changers and tap changer motor boxes

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Substation Maintenance Instruction

ASSET STANDARDS & DESIGN

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SMI 151 ON-LOAD TAP CHANGERS AND TAP CHANGER MOTOR BOXES

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1.0 PURPOSE

To set out in detail the broad maintenance requirements for on-load tap changers and tap changer motor boxes.

2.0 SCOPE

This instruction is to be read in conjunction with Substation Maintenance Instruction SMI 100 - Minimum requirements for maintenance of transmission equipment, for transmission and zone substation equipment and Substation Maintenance Instruction SMI 155 - Power, auto and regulating transformers.

3.0 REFERENCES

Internal

- Company Policy 9.9.1 – Network Asset Maintenance
- Company Procedure GSY 1066 - Worksite Hazard and Risk Assessment
- Endeavour Energy Electrical Safety Rules
- Substation Design Instruction SDI 505 - Minimum design and construction requirements for transmission and zone substations
- Substation Maintenance Instruction SMI 100 - Minimum requirements for maintenance of transmission equipment
- Substation Maintenance Instruction SMI 101 - Minimum requirements for the maintenance of distribution equipment
- Substation Maintenance Instruction SMI 118 - Transmission and zone substation maintenance data entry and defect prioritisation
- Substation Maintenance Instruction SMI 119 - Transmission and zone substation data entry, asset structure and details
- Substation Maintenance Instruction SMI 155 - Power, auto and regulating transformers

External

- *Electricity Supply Act 1995 (as amended)*
- *Work Health and Safety Act 2011*
- *Work Health and Safety Regulation 2011*
- *ENA National Electricity Network Safety Code (Doc 01-2008)*
- *ISSC14 – Industry safety steering committee Sep 2008 – Guide to electrical workers safety equipment*
- *AS60214.1-2005 - Tap Changer :Performance Requirements*
- *AS60214.2-2006 - On Load tap Changer – Application Guide*
- *AS60076.1:2014 - Power Transformers Part 1: General*

4.0 DEFINITIONS AND ABBREVIATIONS

Document control

Employees who work with printed copies of documents must check the Business Management System regularly to monitor version control. Documents are considered “UNCONTROLLED IF PRINTED”, as indicated in the footer.

Ellipse

Endeavour Energy's asset database

SMI

Substation Maintenance Instruction

SDI

Substation Design Instruction

5.0 ACTIONS**5.1 General**

Distinct types or brands of on-load tap changers and tap changer motor boxes may not contain some of the components listed for routine maintenance, in which case that particular component is to be disregarded.

Only transformer oil must be used to clean the tap changer. Solvents of any type must not be used as they may damage the resin coatings of the tap changer cylinders.

For each piece of equipment, all work must be carried out in accordance with the manufacturer's recommendations.

Whenever tap changer maintenance coincides with transformer maintenance, the activities in this document must be combined with the activities in Substation Maintenance Instruction SMI 155 - Power, auto and regulating transformers.

Tests results must be checked before leaving the transformer so that incorrect measurements due to poor terminations or dirty bushings can be rectified and the test repeated.

5.2 Signature Tests

Signature tests consist of winding ratio tests, winding resistance tests of the winding that is connected to the tap changer, as well as winding resistance tests of the secondary winding. Endeavour Energy transformers generally have the tap changer and tapping winding connected to the primary winding.

Signature tests are to be carried out before and after a major overhaul of the tap changer and both sets of results must be recorded in the Endeavour Energy transformer database located in the **G:\EE Maintenance\Transmission** drive under the appropriate substation's folder.

5.2.1 Winding resistances

Voltage and ampere values are recorded and a plot of the resistances must be graphed on site. Deviations must be investigated and input data must be checked. Unexplained deviations must be reported for further follow up.

Differential measurements of more than 0.02 Ohms must be reported for further action. High differential values will affect the arc quenching time.

Large variations of resistance at the lowest tap or the highest tap may be due to insufficient charging time of the insulation before readings have been taken.

Winding resistances will normally follow one another very closely. Constant deviations from the beginning of the test are sometimes indicative of poor connections.

Constant deviations after the K point (coarse winding insertion) are usually indicative of problems with the coarse selector. Consistent high resistances after the K point are usually associated with the changeover switch.

5.2.2 Winding ratios

Ratios must be checked against the nameplate. The tolerance of $\pm 0.5\%$ is acceptable (AS 60076.1 Table 1).

5.3 Routine maintenance schedules

Routine maintenance	Tap changer type	
	Rotary	Other
1.0 INSPECTION		
Inspect the equipment and report any defects.	x	x
Tank		
Inspect for oil leaks or spillage.	x	x
Motor box		
Check for evidence of moisture/condensation.	x	x
Steelwork/hardware		
Inspect for rust, corrosion, poor paintwork condition or other defects.	x	x
Operational check		
Check operation by running tap changer up and down two (2) taps. This check is not necessary if tap changer has operated within the last four (4) weeks.	x	x
Cyclometer reading		
Record cyclometer reading and report reading yearly.	x	x
2.0 TAP CHANGER SIGNATURE TESTS (result reporting format is shown in section 5.4)		
Ratio		
Report ratio test results through the tapping range with the HV and LV connections disconnected. Check that no open circuit occurs during the tap change - for tap changers where the fine selector moves twice for every tap change, check the ratio of the intermediate position.	x	x
Winding resistance		
Report DC winding resistance (ohms) on all taps between: - HV Delta connected winding :- A-B, B-C, C-A - Star connected separate winding :-A-n, B-n , C-n.(Not applicable for auto transformers) - LV a-n, b-n, c-n (principle tap only). - For auto transformers, all tap positions:- a-n, b-n, c-n.	x	x
3.0 OPERATIONAL CHECKS		
Check operation by running tap changer up and down full range of taps.	x	x
Check operation of fans and pumps.	x	x
4.0 MAJOR OVERHAUL		
4.1 AS FOUND CHECKS		
Carry out signature tests as specified in section 2 - TAP CHANGER SIGNATURE TESTS and report results.	x	x
4.2 OVERHAUL – TAP CHANGER		
General		
During and after unit is re-assembled wash down all the components that are normally contained in oil with clean oil. Solvents must not be used on any component of the tap changer	x	x
Examine split segment switch and tap position indicator switch for signs of contamination and build –up of debris, clean where applicable.	x	x
Contacts – selector - diverter(report condition and any replacements)		
Examine for abnormalities, for example burning, loose, bent components, annealed or broken springs, spring tensions or other defects (dress or replace if necessary).	x	x
Examine contact roller for sign of wear	x	x
Check gap between contact hook/pin and moving contact is greater than 1.5 mm , when contact is on tap (For Ferranti OLTC only)	x	
Examine and replace copper strip (auxiliary arcing contact), where applicable	x	x

Routine maintenance	Tap changer type	
	Rotary	Other
Inspect and replace arc chute, where applicable	x	x
Check all contact fasteners are correctly tightened and locking tabs fitted after contact maintenance (where applicable).	x	x
Current collector		
Examine for abnormalities, for example burning, loose, bent components, annealed or broken springs, spring tensions or other defects (dress or replace if necessary).	x	
Separate course selector		
Check alignment if possible.	x	x
Check condition.	x	x
Springs or spring assembly		
Inspect condition, for example annealed or broken springs.	x	x
Flexible connecting braids/leads		
Inspect condition.	x	x
Where required, replace star point braid (sleeved or unsleeved) with sleeved braids.		
Transition resistors/reactors		
Check resistance. The results must be consistent with the manufacturers' recommendations.	x	x
Insulation - Bakelite assembly carrier - Insulated driving components - Transition resistor/reactor insulators		
Inspect bushings for abnormalities, cracks, chips, treeing, tracking or other defects.	x	x
Clean and examine barrier boards for signs of surface damage (Where applicable)		
Electrical connections		
Inspect condition.	x	x
Check tightness.	x	x
Energy accumulator		
Inspect condition (for example replace if condition is unsatisfactory or if the number of operations will exceed recommended limits before next scheduled maintenance).	x	x
4.3 OVERHAUL MOTOR BOX¹		
Gear box		
Check condition and top up if necessary.	x	x
Drive shaft including pins, covers and couplings		
Check condition and lubricate if necessary.	x	x
Repair or replace pins and couplings, if required.	x	x
Check if drive shaft covers are fitted properly, where applicable	x	x
Cam Switch		
Examine cam switch, clean and repair any defects.	x	
Auxiliary contacts		
Clean dial switches, cams and the like.	x	x
Lubricate dial switches, cams and the like.	x	x
Contactor		
Examine for abnormalities, for example burning, loose, components (replace if necessary).	x	x
Hand cranking		

¹ **Note:** For *Reinhaussen* C1400 coupling drive shaft, remove existing bolts, drill coupling through and bolt using 8mm bolts, lock nuts and spring washers.

Routine maintenance	Tap changer type	
	Rotary	Other
Examine condition of motor declutching mechanism (adjust if necessary).	x	x
Examine electrical interlocks (adjust if necessary).	x	x
Examine range indicator (adjust if necessary).	x	x
Examine backlash (adjust if necessary).	x	x
Wiring		
Inspect condition.	x	x
Thermal overloads		
Examine condition (replace if necessary).	x	x
Motor		
Insulation resistance at 500 V. The results must be consistent with the manufacturer's recommendations.	x	x
Brake		
Insulation resistance at 500 V. The results must be consistent with the manufacturer's recommendations.	x	x
Heaters and thermostats		
Check operation, repair/renew if faulty.	x	x
Inspection lamp		
Check operation.	x	x
Doors and seals		
Inspect condition, repair doors and renew seals if required.	x	x
4.4 FINAL CHECKS		
Carry out signature tests as specified in section 2 - TAP CHANGER SIGNATURE TESTS and report results.	x	x
Oil		
Check level is correct.	x	x
Replace switch tank oil.	x	x
Indication		
Check that the tap indicated in the motor box is the same tap showing in the window of the fine selector.	x	x
Re-check that the tap indicated in the motor box is the same tap showing in the window of the fine selector after manually raising and lowering the tap changer.	x	x
Adjustments		
Check the centralising of the motor drive (adjust if necessary).	x	x
Limits – mechanical stops – declutching mechanism - electrical		
Check raise and lower operation and adjust if necessary.	x	x
Operation		
Report counter reading at the commencement of and at the completion of operational checks.	x	x
Check parallel operation (as master and follower transformer).	x	x
Check manual operation. Leave local-remote selector switch in remote mode	x	x
Check electrical operation (both local and remote).	x	x

5.4 Record format

TAP CHANGER TEST RESULTS								
Asset data								
Asset ID no:					Manufacturer:			
IE no:					Manufacture type:			
Location / substation					Serial no.			
Device no:					Test date			
HV winding resistance test results					Turns ratio test results			
Tap no.	A-B Phase	B-C Phase	C-A Phase	mean	Calculated Ratio	A Phase	B Phase	C Phase
						MEAS.	MEAS.	MEAS.
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
LV winding resistance test results tests								
A phase			B Phase			C Phase		
a-n			b-n			c-n		

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management has the authority and responsibility for approving this instruction.

Manager Asset Standards & Design has the authority and responsibility for making recommendations to the **General Manager Asset Management** in respect to this instruction.

Network Maintenance Manager has the authority and responsibility for keeping the content of this instruction up to date.

Regional Transmission Managers have the authority and responsibility for:

- maintaining transmission and zone substation on-load tap changers and tap changer motor boxes in accordance with this instruction;
- engaging Endeavour Energy employees and/or contractors who have appropriate qualifications and are competent to carry out the work; and
- providing appropriate equipment and training.

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

- meeting the requirements of this instruction, and SMI 100 (for transmission and zone substation equipment), when carrying out maintenance on transformers;
- working in accordance with local and statutory requirements;
- upholding a high level of public safety;
- working in accordance to Endeavour Energy's Electrical Safety Rule;.
- updating Endeavour Energy's asset database; and communicating abnormalities found in the transformer and on-load tap changers to the Regional Transmission Manager and the Network Maintenance Manager.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Network Maintenance Manager

Documentation Distribution Coordinator : Branch Process Coordinator