WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 142/1

Earthing and Auxiliary Transformers

Policy Summary

The specification covers Western Powers requirements for Earthing and Auxiliary Transformers for use on its network.

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Implementation Date: **November 2020**

Approved by

Carl Ketley-Lowe
Engineering Policy Manager

Date: **4th November 2020**

Target Staff Group	**Major Projects, Engineering Design, Primary System Design, Purchasing**
Impact of Change	**Green**
Planned Assurance checks	**Purchase of compliant products**

IMPLEMENTATION PLAN

Introduction

This document defines the earthing/auxiliary transformers for use within WPD and provides a standard for purchasing to go to tender with.

Main Changes

Inclusion of appendix 1 table, inclusion of standard ratings for all 4 Western Power license areas.

Impact of Changes

The impact of changes affect Purchasing, Primary system design, engineering design and Major Projects.

Implementation Actions

Implementation is immediate.

Implementation Timetable

This policy can be implemented with immediate effect.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
November 2020	• Changes to included standardisation • General tidying of the document for improved clarity • Inclusion of new ordering proforma	Andrew Reynolds
February 2019	• First issue	Andrew Reynolds

Contents

1.0 General Requirements

This document details requirements for earthing and auxiliary transformers AND SHALL BE READ IN CONJUNCTION WITH THE FULL ENGINEERING SPECIFICATION EE1.

1.1 Unless otherwise specified, the type of cooling shall be ONAN as defined in IEC 60076.

1.2 The higher voltage terminals will be directly connected to the lower voltage terminals or the tertiary terminals, as applicable, of the associated transmission transformer.

1.3 Unless otherwise specified, the fault level at the LV or tertiary terminals of the transmission transformer will be as stated below unless in the Schedule.

System Fault Levels

Table 1:

Nominal System Voltage	kV	66	33	22	11	6.6	0.415
Fault Level	MVA	3,600	1,500	750	400	250	31

1.4 The insulation levels shall be in accordance with IEC 60076. Apart from 11kV which will be 95kV BIL

1.5 Transformers shall comply with the requirements of IEC 60289 in their ability to withstand short-circuits except that the over-current conditions shall be as defined below and the initial winding temperature shall be the sum of the maximum ambient temperature (40°C) and the temperature rise obtained by the continuous operation at continuous maximum rating (CMR).

1.6 When operating at CMR, all transformers shall be capable of withstanding, for 3 seconds, the current occurring when a short circuit is applied between any or all of the lower voltage terminals with full line voltage maintained at the higher voltage terminals.

1.7 The guaranteed no-load and load losses of each transformer shall be as stated in the Schedule. Unless otherwise specified they shall be guaranteed subject to the tolerances permitted by IEC 60076.

1.8 With the exception of auxiliary transformers having an HV winding rated at <11 kV the sound power level and vibration of all transformers shall comply with Clause 11, of WPD Specification EE 1. The guaranteed sound power value shall be stated by the Tenderer in the Schedule; the measured value shall not exceed the declared value.

1.9 The Vector group(s) of all transformers may be such that the voltage of the secondary windings will be in phase with the higher voltage system to which the transmission transformer is connected. Where the transmission transformer is arranged for alternative vector groups, a corresponding arrangement shall be included for the earthing transformer or auxiliary transformer by means of links, which shall be located within the tank and readily accessible through an inspection opening.

1.10 When on normal tap, with rated voltage applied between terminals at rated frequency, the magnetic circuit of earthing transformers and auxiliary transformers shall have a flux density not exceeding 1.65 Tesla

1.11 The LV windings shall be terminated as follows:-

(i) CMR <550kVA:

Unless otherwise specified in the Schedule the transformer shall be fitted with an approved type of three-pole, air-break, industrial pattern, fully weatherproof, combined switch-fuse incorporating a bolted neutral link and a gland entry for a 4-core cable. No part of the switch-fuse operating handle, when in the closed position, shall be at a height greater than 1.4 m above plinth level and the arrangement for operation shall comply with the safety air clearances detailed. The transformer side of the bolted neutral link shall be earthed to a boss, within the chamber, by a removable connection strap. Removal of the neutral link shall not disrupt the transformer earthing.

(ii) CMR >550kVA:

A cable box as detailed in the Schedule.

Note: Where cable boxes are used, disconnection chambers are not required but, to facilitate cable testing, hand holes shall be provided giving access to the inside of the transformer tank to permit disconnection of the bushings. With the internal connections removed and the bushings covered by at least 50 mm of oil, adequate clearances shall exist to withstand the application of the appropriate cable test voltage.

1.12 The following tanks and fittings, complying with this Specification requirements, shall be provided:-

- Conservator
- Maintenance free de-hydrating breather
- Pressure relief device
- Gas and oil actuated relay
- Oil temperature indicator
- A suitably rated switch fuse unit

1.13 Radiators shall comply with the requirements of the specification, with the exception that valves between the radiators and the tank need not be supplied.

1.14 Valves shall be fitted in accordance with the requirements of the Specification, except that the combined drain/filter valve and the 'diagonally opposed filter valve', shall be 25 mm.

1.15 All breather pipes shall be brought down to not more than 300mm from the base of the transformer not including any plinth or frame.

1.16 A metal frame shall be supplied to support the transformer unless otherwise specified. The minimum height of the frame shall be enough to give overall clearance to the base of the neutral bushing of 2.9m.

1.17 The PRD test point needs to have a suitable cover to prevent operation by interference but not prevent operation under fault conditions.

1.18 Buchholz relay test plunger needs to be suitably covered to prevent interference.

1.19 The PRD vent pipe needs to be brought down to low level and have a vermin shroud fitted in the end to prevent leaves and animals entering the pipe

2.0 Earthing Transformers

2.1 The HV windings shall be terminated with bushings or Euromold 'C' profile bushings in a cable box detailed in the Schedule. The HV neutral shall be brought out via an oil to air outdoor bushing not a Euromold type bushing unless otherwise specified.

2.2 The rated short time current through the HV neutral unless otherwise stated shall be as given below:-

Table 2:

Voltage	kV	6.6	11	22	33	66
Rated short-time current (30 seconds)	Amp	1,320	1,050	750	750	500

2.3 When operating at CMR of the secondary winding, the HV winding shall be capable of withstanding, simultaneously, the rated short-time current and, for 3 seconds, the current obtained with a short-circuit applied between one HV line terminal and the HV neutral terminal with full line voltage maintained at the HV line terminals.

2.4 Lower voltage windings shall be provided to give a 400/230 volt, 3 phase, 4 wire supply - unless this requirement is specifically excluded in the Schedule.

2.5 Unless a higher rating is specified by the Purchaser the standard rating for the lower voltage winding of earthing transformers shall be 200 kVA.

2.6 Unless specified by the Purchaser the declared HV/LV impedance for earthing transformers shall not exceed the value given for auxiliary transformers of equal rating, see Tables 3 and 4 below.

2.7 All CTs shall be externally mounted resin encapsulated ring type and not located within the tank this will facilitate easier testing. These shall be specified at time of tender and supplied by the manufacturer allowing a suitable mounting arrangement to be manufactured to support these CTs. These CTs shall have a water proof termination box on them. The standard WPD drawings listed in EE1 show the standard LV REF CTs these will match these if not specified at time of tender

Table 3: Standard Auxiliary and Earthing Transformer Ratings.

	No-load Voltage Ratio (kV)	**Continuous Maximum Rating (kVA)**	**Impedance at CMR at 75°C (%)**
Auxiliary Transformers	6.6/0.400 or 11/0.400	200	4.75
		400	4.75
		500	4.75
		800	4.75
		1,000	4.75
	22/0.400 or 33/0.400	200	5.5
		400	5.5
		500	5.5
		800	5.5
		1,000	5.5
	66/0.400	200	6.0
		400	6.0
		500	6.0
		800	6.0
		1,000	6.0
Earthing Transformers	11/0.400 22/0.400 33/0.400 or 66/0.400	200 See Clause 2.5	See Clause 2.6

2.8 The zero sequence impedance of the HV winding may be specified, by the Purchaser, to have a minimum value. The guaranteed value shall be stated by the Tenderer in the schedule. The measured value shall be within the range plus 20% and minus zero of the guaranteed value.

2.9 The impedance between the higher and lower voltage windings shall comply with the requirements of Table 3; the guaranteed value shall be stated by the Tenderer in the Schedule.

2.10 The Vector group symbol shall be Zy1 with changeover links provided on the lower voltage winding to permit reconnection equivalent to Zy11.

2.11 A thermometer pocket shall be provided.

2.12 A self-dehydrating breather shall be supplied.

2.13 The manufacturer shall fit earth tape from the neutral bushing down through the CT to the base of the tank to a suitable earth point, the earth tape shall be painted the same colour as the transformer. The earth tape shall also be supported on standoff insulators. Earth tape shall be as per Western Power Engineering Specification EE 89.

2.14 Standard ratings of earthing transformer for each Western Power area.

Table 4: Standard Earthing Transformer specifications

Area	Zero Sequence Impedance (Ohms)	Short time current rating (A) 30s	Voltage Ratio (V)	Rating (KVA)
East Midlands	57.15	1000	33000/400	200
South Wales	13.47 (use with 25 ohm resister)	750	33000/400	200
South West	76.2 Cornwall special transformers 20	750 1050 400 A for 8 hours	33000/400 33000/400	200 200
West Midlands	Low impedance 13 (use with 19 ohm resister) High impedance 57.1	1000 1000	33000/400	200

3.0 Auxiliary Transformers

3.1 The HV windings shall be fitted with bushings or cable boxes as detailed under item in the Schedule

3.2 The CMR and the voltage ratio shall be as specified under the Schedule chosen from the standard ratings and voltage ratios listed in Table 3.

3.3 Transformers having their HV winding rated at <11kV, shall have a sound power level of less than 63dBA.

3.4 Unless otherwise specified, the impedance between the higher and lower voltage windings shall be as specified in Table 3, subject to the tolerances permitted by IEC 60076.

3.5 Unless otherwise required for compliance with the Schedule or Clause 1.1.9, the Vector symbol shall be DzO with changeover links on the higher voltage winding to permit reconnection to Dz6.

3.6 A thermometer pocket shall be provided.

3.7 A self-dehydrating breather shall be supplied

4.0 Neutral Coupler

4.1 A neutral coupler shall be supplied with all Earthing/Auxiliary transformers and shall be matched to that transformer. The neutral coupler shall be designed to limit the rise of phase to neutral voltage under system earth fault conditions. It shall comply with all relevant sections of this Specification.

4.2 The Neutral Coupler shall have the following characteristics

a) Vector Symbol: Zn
b) Rated Power: 66.7kVA
c) Rated Voltage: 415V
d) Rated Current: 92.7A, continuous
e) Rated Neutral Current: 278A, continuous
f) Zero sequence impedance per phase: 0.027 ?
g) Insulation level: 50Hz withstand: 3kV rms

Alternative ratings may be specified, at time of tender, where a neutral coupler is being purchased to match an existing earthing transformer.

4.3 The neutral coupler shall be mounted on the earthing transformer and connected as shown in Figure A1. As an alternative, if specified at time of tender, the coupler may be plinth mounted and connected as shown in Figure A2.

4.4 The connections between the Earthing Transformer, Neutral Coupler and LV fuse switch shall be provided by the manufacturer. The terminations shall be within suitable cable boxes. Shrouded open terminal bushings are not acceptable

4.5 The unit shall be suitable for outdoor use and have the following features

a) Lifting lugs
b) Tank earthing terminal
c) Silica gel breather
d) An oil level gauge
e) Combined drain and sampling valve

Figure A1 - Earthing transformer mounted arrangement

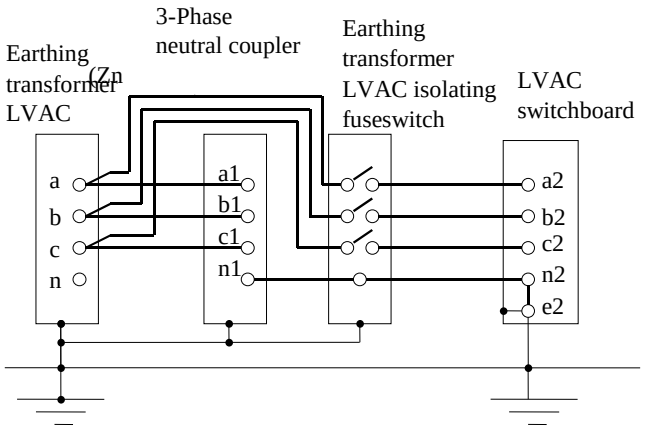


Figure A2 - Plinth-mounted, Arrangement A

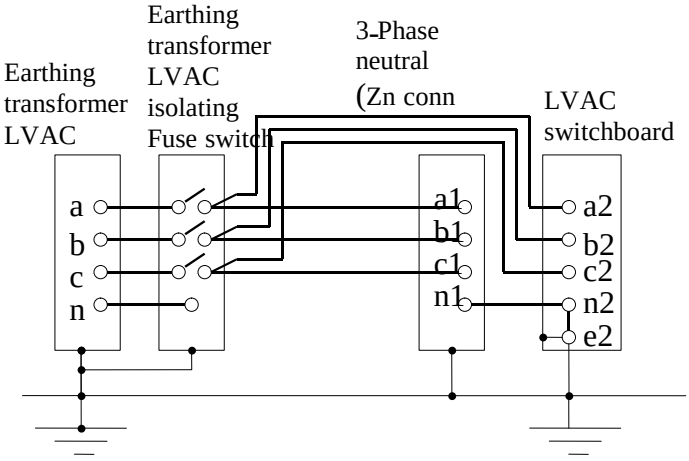
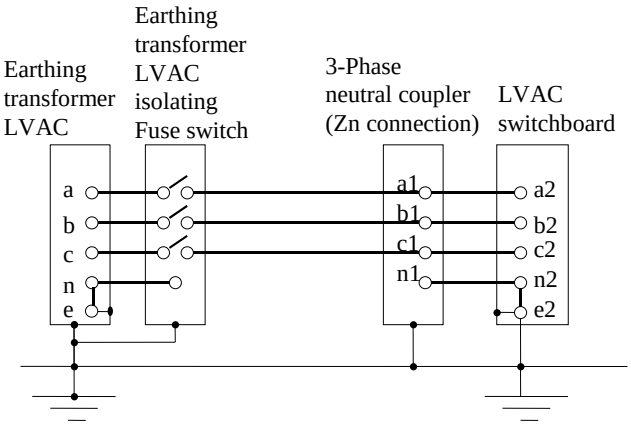


Figure 2A Plinth mounted, Arrangement B



Earthing and Auxiliary transformers for use of systems up to 132kV

Appendix 1 Schedule of requirements

Item	Description	
1	Separate Earthing / Auxiliary Transformer	Yes / No
2	I f 1 is Yes Voltage Ratio	 33/0.400
3	Rating	200 kVA
4	HV Short time current rating 30s	750/ 1000/ 1500
5	HV Terminal Arrangement	Outdoor bushing / Cable box (Euromold C profile) HV neutral outdoor bushing
6	Vector Group (if not standard)	
7	Zero Sequence Impedance (Ohms per phase)	
8	Neutral CT rating (if not standard)	

APPENDIX A

SUPERSEDED DOCUMENTATION

This document supersedes EE SPEC: 142 dated April 2019 which has now been withdrawn.

APPENDIX B

RECORD OF COMMENT DURING CONSULTATION

EE SPEC: 142/1 – Comments

APPENDIX C

ASSOCIATED DOCUMENTATION

EE 1

APPENDIX D

IMPACT ON COMPANY POLICY

None

APPENDIX E

KEY WORDS
Earthing, Auxiliary