Electricity Distribution

nationalgrid

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 1/7

Relating to Continuous Maximum Rated (CMR) System Transformers for use on systems up to 132kV

Policy Summary

This specification covers Western Power Distribution's requirements for 33kV, 66kV and 132kV continuous maximum rated system transformers, and associated earthing / auxiliary transformers. It is based on ENA Technical Specification 35-3 Issue 2 - 2014 and must be read in conjunction with that document.

Author: **Andrew Reynolds**

Implementation Date: **April 2019**

Approved by

Policy Manager

Date: 16 April 2019

All references to Western Power Distribution or WPD must be read as National Grid Electricity Distribution or NGED

IMPLEMENTATION PLAN

Introduction
This document defines the 132kV CMR Transformers used within WPD and provides a standard with which the Purchasing Section can go out to tender with.

Main Changes
The document has been updated to include minor changes and removal of the Earthing and Auxiliary transformers into their own specification. Inclusion of a continuity test and visual inspection of the chamber that houses the Thompson strap, this is for all new dual LV grid transformers to prove that the strap has been fitted after routine testing in the factory.

Impact of Changes
The impact of changes affects the Procurement Team, 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**
April 2019	Minor changes to tidy document up Creation of engineering specification for Earthing Auxiliary transformers Inclusion of continuity test and visual inspection of Thompson strap for dual LV transformers	Andrew Reynolds
February 2017	Page 93 - Standard CT arrangement drawings have been added	Andrew Reynolds
January 2017	• Inclusion of inhibited insulating oil • Spelling changes and grammar • Inclusion of latest ENATS • Inclusion of ECO directive	Andrew Reynolds

CONTENTS

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1.0 SCOPE AND SERVICE CONDITIONS

This specification covers Western Power Distribution's requirements for 33kV, 66kV and 132kV continuous maximum rated system transformers, and associated earthing / auxiliary transformers for use on 50Hz systems having 33kV or 11kV neutral earthed directly or through resistance, reactance or arc suppression coil at one or more points.

All equipment supplied under this specification will meet the relevant technical requirements of ENA_TS_35-3_Issue 2 (2014).pdf - Continuous Maximum Rated (CMR) System Transformers for use on systems up to 132kV.

Additional clauses contained within this specification are in addition to the requirements of the standards outlined in ENA Technical Specification 35-3. Where there is any conflict between ENA Technical Specification 35-3 and this document, then this specification shall take precedence.

Manufacturers should consider carefully the implications of arc suppression coil earthing of both 33kV and 11.5kV systems on the insulation requirements of the equipment supplied.

The transformer and its ancillaries shall be designed such that it can continue in operation in times of flood when water levels could reach 1m above the plinth level. All parts below this level shall be sealed to allow submersion. Items not suitable for submersion shall be located above this level, with the exception of cooling fans which although will preferably be fitted above this level, consideration will be given to an arrangement where the fans are below this 1m level. In this case it is accepted that the fan motors will be ruined by the flood. Any items below the 1m level that are not suitable for submersion shall be listed in Appendix 4. Together with the reason for the non-compliance and the extent of damage and rectification needed following subsidence of the flood.

Clause numbers in this specification correspond to clause numbers in ENA Technical Specification 35-3.

Transformers offered by manufacturers are required to satisfy the eco-design regulations 2009/125/EC and to conform to the requirements associated with Commission Regulation 548/201 with regard to small, medium and large power transformers.

The energy performance of a transformer at its equivalent CMR rating shall comply with the maximum allowed values of load losses and no load losses or peak efficiency index (PEI) for Tier 1 stated in the appropriate tables of Annex 1 of the eco-design regulations.

2.0 NORMATIVE REFERENCES

Clause 2 of ENA Technical Specification 35-3 applies.

3.0 DEFINITIONS

Clause 3 of ENA Technical Specification 35-3 applies.

5.0 RATING

Clause 5 of ENA Technical Specification 35-3 applies with the addition of -

- Nominal transformer lower voltages shall be either of the following 11kV, 11.5kV, 33kV or 66kV as set out in the Schedule.
- 33kV dual ratio transformers for which the voltage ratio at no-load, on the principal tap, shall be 33000/11500/6900 V.
- All earthing connections shall be capable of withstanding prospective fault currents for a minimum of three seconds.

5.3 The following preferred values of rated power shall be added to Table 1 -

Nominal transformer higher voltage	132kV
Nominal transformer lower voltage	66kV
Transformer continuous maximum rating (CMR) (MVA)	30, 45, 60 or 90

6.0 REQUIREMENTS FOR TRANSFORMERS HAVING A TAPPED WINDING

Clause 6 of ENA Technical Specification 35-3 applies with the addition of -

Unless a multi-start tapping winding is employed, all tapping's should be made on the outside winding face. Tapping's brought out between turns or discs are not acceptable.

6.4 If no figures are quoted in Item 2 of Appendix 1 - Schedule of Requirements, the tapping range shall be +10% to -20% in 1.67% steps

6.5 If no figures are quoted in Item 3 of Appendix 1 – Schedule of Requirements or impedance graph supplied, the impedance shall be:-

For 132/33kV:- 25% at nominal tap, 22.5% at minimum tap (Tap 19, 105.6/33kV) and 26% at maximum tap (Tap 1,145.2/33kV) all on a 100MVA base.

For 132/66kV:- No 'standard' impedance is used. Please contact WPD for the required impedances.

For 132/11kV:- 85% at nominal tap, 80% at minimum tap (Tap 19, 105.6/11kV) and 89% at maximum tap (Tap 1, 145.2/11kV) all on a 100MVA base.

The impedance at all tap positions shall be within the tolerances quoted in Table 1 of BS EN 60076-1.

6.6 The transformer and all connections shall be capable of operating at any tapping position on a load cycle **preceded by 65% of CMR** for 24 hours then **130% of CMR for 8 hours** followed by **16 hours at 78% of CMR** with an ambient temperature of **20°C** without exceeding a hot spot temperature of **140°C**. It is recognised that under these operating conditions, loss of insulation life will occur.
(Only applies to transformers purchased from February 2017)
The maximum winding hotspot temperature shall be 140°C.

7.0 CONNECTION AND PHASE DISPLACEMENT SYMBOLS

Clause 7 of ENA Technical Specification 35-3 applies with the addition of -

Vector change links shall be provided. These shall be easily accessible via an access port in the tank lid.

8.0 RATING PLATES

Clause 8 of ENA Technical Specification 35-3 applies with the addition of -

All rating plates and valve function diagram plates shall be durable such that they remain legible for a period of 50 years when exposed in an outdoor coastal polluted environment without maintenance other than cleaning with water.

A valve function diagram plate shall be provided - Figure 4 illustrates the required content.

The plates detailed above, shall be fitted to transformers and reactors at an approximate height of 1.7m above plinth level.

8.1 Information to be given in all cases

(k) Connection symbol(s) shown in a manner that states which one has been connected.

(o) The mass of insulating oil shall be shown for each portion of the transformer - main tank, tap-changer, pipework and coolers.

8.2 Additional information to be given when applicable

Vacuum capability will be applicable to all system transformers. These plates shall carry information on the vacuum capability of the unit and containing any necessary information relating to precautions on valve positions, barrier boards, coolers etc.

9.0 MISCELLANEOUS REQUIREMENTS

Clause 9 of ENA Technical Specification 35-3 applies with the addition of -

9.2 Oil preservation system

The oil preservation system shall be free breathing with a maintenance free dehydrating breather. It shall be positioned so that it is accessible for repair/maintenance with the transformer live (3m clearance from live bushings). Details of the system used shall be provided at time of tender for approval.

10.0 TOLERANCES

Clause 10 of ENA Technical Specification 35-3 applies.

11.0 TESTS

Clause 11 of ENA Technical Specification 35-3 applies with the addition of -

11.1 Table 2 - the rated lightning impulse voltage (LI) kV (peak) for 132kV nominal system voltage shall be 650. In-tank surge arrestors are not permitted.

11.2 Determination of Sound Levels

Maximum sound power levels in Table 4 are replaced with the following -

Primary voltage	ONAN Sound Power Level dB(A)	ONAF/OFAF Sound Power Level dB(A)
33kV	65	80
66kV	74	80
132kV	75	80

11.3 Frequency Response Analysis

Frequency Response Analysis is required before leaving the manufacturer's works and again on site. The cost of these tests shall be identified separately at the time of tender.

11.18 Site Tests

All the site tests listed in 11.18 are required, along with those additional site tests listed below. All site tests shall be witnessed by WPD Project Engineer. The first test to be completed on site before the transformer is offloaded from the transport vehicle is the core to earth tests; these will be repeated once the transformer has been landed on its plinth.

Where a dual LV winding transformer (double bubble) a continuity test will be completed and a visual inspection of the Thompson Strap chamber will be completed.

(iv) Ratio test at all tap positions (including HV winding magnetisation current measurement in all phases at all taps and proof that no open circuit occurs during each tap-change operation.

(xi) For all C.T.'s:-
- (a) DC resistance measurement (all ratios)
- (b) Polarity check (flick test)
- (c) Magnetisation curves (all ratios)

(xiv) Appropriate tests to prove correct operation of any ancillary equipment.

12.0 ELECTROMAGNETIC COMPATIBILITY (EMC)

Clause 11 of ENA Technical Specification 35-3 applies.

14.0 TRANSFORMER DETAILS

Clause 14 of ENA Technical Specification 35-3 applies with the addition of -

14.2 The manufacturer will provide oil in accordance with IEC 60296 high grade inhibited oil.

The oil offered shall have the following stand out properties.

Property	**Test Method**	**Value**
Dielectric Dissipation Factor at 90 ^{o}C and 20 ^{o}C	IEC 60247	Less than 0.0025
Flash Point (^{o}C)	ISO 2719 ASTM D93	>170
Total Sulphur Content (ppm)	IP 373 ISO14596	Non-detectable (less than 1 ppm)
Breakdown Voltage (kV)	IEC 60156	>50kV (Untreated)
Breakdown Voltage (kV)	IEC 60156	>70kV (Treated)
Corrosive Sulphur	DIN 51353 or ASTM D1275B	Non corrosive
PCB (ppm)	IEC 61619	Non-detectable (less than 1 ppm)
Water Content (ppm)	IEC 60814	<15

The oil used needs to be identified at time of tender and on the name plate for future reference. An identifying label needs to be attached at every point on the transformer where a pipe can be attached to fill the transformer with oil, this label needs to identify the oil manufacturers name and oil brand, for example only fill this transformer with SHELL DIALA S4ZXi

14.3 Cooling shall be ONAF or OFAF. Unless otherwise specified in writing, a separate cooler bank design is required, which shall be arranged to permit the later construction of a noise suppression building around the transformer without dismantlement of the transformer. Specific requirements are set out in section 15 following.

14.5 Auxiliary DC nominal voltages are either 24, 50V or 110V as stated in the Schedule 1. Whilst minimum voltages shall be taken as 80% of nominal, it should be noted that under boost charge conditions the 110V DC voltage may rise to 138 V. Connected equipment must function correctly and without damage throughout these voltage ranges.

15.0 CONSTRUCTION DETAILS

Clause 15 of ENA Technical Specification 35-3 applies with the addition of -

15.1 Tanks and covers

Fabricated under-bases shall be ventilated to prevent corrosion. Fabricated underbases shall incorporate skids and be designed to prevent retention of water. Detachable underbases shall not be used.

Oil tight welded seams shall not be covered longitudinally by tank stiffeners. Box section stiffeners shall incorporate drainage holes at their lowest point(s).

Transformers with separate coolers shall be arranged to permit connection of the coolers to either end of the tank without modifications to the transformer.

Tanks of transformers/reactors shall permit the complete tanked unit to be moved under the following conditions without damage.

(i) When completely filled with oil: - lifted by jacks, and to be moved, in any direction, using rollers, plates or rails,

(ii) When filled with agreed transport medium:

(a) To be lifted by crane,

(b) To be moved by road, water and, when specified, by rail transport.

It shall be possible to move the equipment in its tank and filled with oil, in any direction, using rollers, plates or rails, without damage. A design which necessitates slide rails being placed in discrete positions is not acceptable.

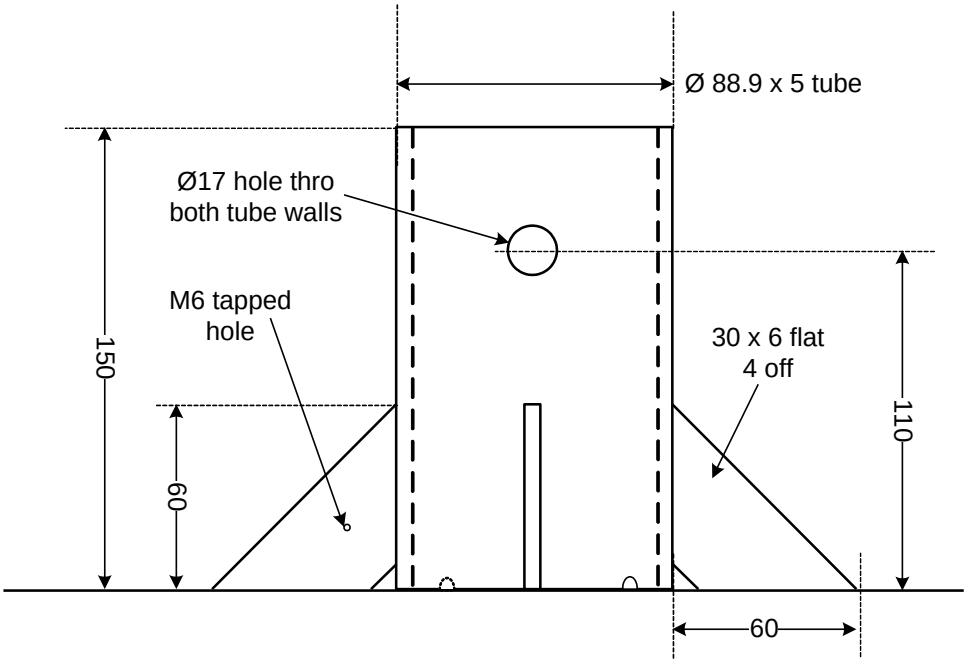
The transformer free standing height when arranged for transportation shall not exceed 4000mm, unless a larger height has been specifically agreed in writing prior to contract placement, up to a maximum of 4880 mm.

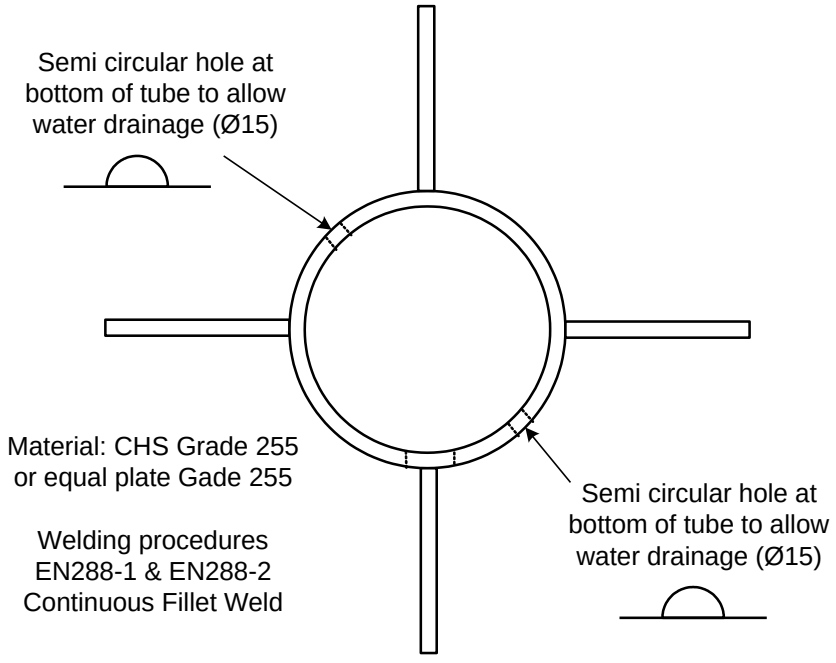
15.1.1 Fall arrest

(i) A socket for insertion of a work positioning/restraining post (Ridge Gear SSP Sub-Station fall arrest post) shall be provided as near the centre of the transformer lid as practicable. This shall be as detailed in the Figure below.

(ii) In addition to the socket above lifting eyes shall be provided, suitably spaced in the centre and along the length of the transformer lid, to be used as clip on points for work positioning restraining.

(iii) Fall arrest posts shall be supplied by the manufacturer.





15.1.2 Shielding of moving parts and 230V connections

Moving parts which pose a risk of injury, such as motors, shafts, fans, tap-changer mechanisms etc, shall be effectively shielded. Removal of shields shall require the deliberate use of tools. Small wiring terminals carrying 230V to earth or higher shall be effectively shrouded.

15.1.3 Inspection openings and label plates

Suitable fixings shall be provided on the tank and its cover for accommodating the rating and information plates specified.

Covers shall be labeled to indicate their function.

Terminals shall be marked with labels approximately 100mm diameter carrying terminal marking eg A_1 a_2 etc.

15.1.4 CT terminal boxes

HV CT terminal box shall be weather-proof and waterproof to prevent water ingress in an outdoor environment. Access to the CT terminals shall be by a removable front cover, with the cable and gland remaining in position when the cover is removed.

15.1.5 Sound attenuation

Every care shall be taken to ensure that the design and manufacture of all transformers and auxiliary plant is to be such as to reduce noise and vibration. This is a matter of primary importance and special attention shall be given by the Contractor to ensure compliance with this requirement.

Anti-vibration mountings for separately mounted coolers, pumps, etc, are not required. These shall be bolted to the plinth by the Contractor.

Transformers shall be arranged to permit installation of a sound attenuation enclosure.

In addition to the clearance requirements stated in 13.1 (i), the following apply -

Between nut and bolt fixings of pipe-work, and turrets of transformers/reactors, to:-

(a)	Enclosure walls	150mm
(b)	Enclosure roof	150mm

Special provision in the enclosure roof for easy access to in-tank tap-changers, (and for their maintenance equipment, such as lifting beams), tank inspection covers, and terminal boxes shall be agreed at time of tender. If access to the tank cover is required, this shall be shown on the Contractor's drawings and will be obtained by removing roof cover units as necessary; the roof support construction will be arranged to facilitate such access.

Sound attenuation enclosures will generally be arranged as shown in noise attenuation enclosure drawing, and the following shall be noted:-

(i) Enclosures will normally be a combination of brick, concrete and steel or laminated sheet, so designed that sections of the structure can be removed without involving complete dismantling. The bonding material of both roof and walls will permit easy removal of appropriate sections, when required.

(ii) The overall thickness of civil works for the sides ends and roof, including any support structures, will not exceed:-

Sides/ends	Roof
460mm	300mm

(iii) Annular spaces around pipe-work, bushing turrets, coordinating gap structures, etc, passing through the walls or roof, will be filled with bitumastic weatherproof felt or equivalent resilient material.

(iv) Ventilation of enclosures will be provided to reduce possible build-up of vapors. The total area of such apertures (inlet and outlet) will not exceed 0.1% of the total area of the walls.

(v) Two doors will be provided in the enclosure, arranged sensibly diagonally opposite, both being fitted with "panic" bolts. One door shall be positioned adjacent to any tap change operating mechanism.

(vi) Normal fire prevention civil works will be incorporated in the enclosure construction, including any necessary effluent pipes to oil soak-away pits due regard being paid to the requirement to maintain the effectiveness of oil containment measures.

(vii) The enclosure roof construction will be designed to support its own weight and allowances made for:-

(a) Wind loading

(b) A point load of 890 Newtons at any position

(c) A uniformly distributed load of 720 N/m^2

(viii) Access requirements to tank inspection covers and terminal boxes shall be separately specified.

15.1.6 Earthing

All tank attached cubicles, cooling fan motors, oil circulating pumps, driving mechanisms, etc, shall be bonded to their supporting structures. All tanks, separately mounted cooler structures and marshalling kiosks will be connected to the main earth bar by means of subsidiary connections, carried out under another Contract.

Earthing tags shall have a blanking plate fitted over them before painting, which can easily be removed, on site, leaving a clean face for connection of the earth.

Cover mounted structures such as the tanks of externally mounted protection current transformers and shields to give protection from arc damage, shall be bonded to one of the tank earthing points by a separate connection having a cross-sectional area of not less than 300 mm² copper.

These earth connections shall be securely bolted to the transformer tank at a minimum of 300mm spacing with shear head stainless steel bolts.

Earthing tags shall be provided on the main tank, as close as possible to, and below, each surge diverter mounting point. The facility shall be provided to support 50mm x 6mm copper earth tape horizontally between the 3 earth tags mentioned above and vertically from each tag to ground level. For security reasons (copper theft) it shall be possible to securely bolt the earth tape to the transformer using stainless 12mm shear head bolts at a maximum spacing of 300mm.

The transformer lid shall be bonded to the main tank with 200mm² copper at a point as close as possible to the central earth tag mentioned above.

Surge arrestor earthing shall be provided by the manufacturer and shall comply with WPD ST TP21S, this earthing shall consist of copper earth tape and shall be brought to ground level in straight lines from each individual surge arrestor and secured to the tank sides via insulating stand offs. No other earths shall be connected to these earths. This arrangement shall be provided for the high voltage and low voltage sides of the transformer where surge arrestors are fitted.

15.2 Surface finish

Unless otherwise agreed the following equipment shall be hot dipped galvanised:

(a) Radiators

(b) Fan supports spiders and guards

(c) Arcing horns

(d) Marshalling kiosk base support frames

(e) External guards eg neutral CTs, expansion joints

Unless otherwise agreed the exterior of following equipment shall be zinc sprayed:

(a) Marshalling kiosks and cubicles

(b) Refrigerated breather control boxes

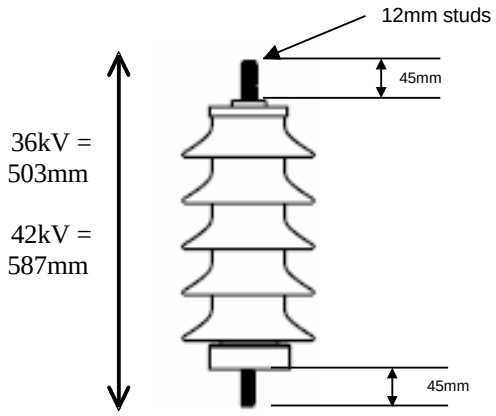
15.3 Terminals

Fixings shall be provided on the tank adjacent to the neutral terminal(s), to accommodate support for externally mounted protective current transformers connected either in the neutral or in the neutral phase ends.

Bushing terminations shall be provided with surge arrester brackets, located such that the arrester would be outside a sound attenuation enclosure. The earthing arrangement shall be brought to ground level from the mounting brackets and fixed to the transformer along the route, leaving earthing points at the base of the transformer. These earth connections shall be securely bolted to the transformer tank at a minimum of 300mm spacing with shear head stainless steel bolts approval of arrangement will need to be sought from WPD prior to build.

The following surge diverters are in current use -

33kV (42kV used on arc suppression earthed systems in Cornwall) utilise a Coopers arrester as shown below:



At 132kV, ABB is PEXLIM Q132-YV145E arresters with or without insulating base are currently used.

15.3.1 and 15.3.2 Cable terminations

This section details the requirements for: -

- Unfilled Cable Enclosures / Cable Boxes
- Inner Cone Separable Connector Chambers

Environmental protection shall: -

Comply with the requirements of EN 60529 IP33 classifications. Holes in equipment, e.g. cable boxes, gland plates, glands etc., and shall be sealed during transport and storage, to avoid ingress of water and dirt.

When carrying continuous rated current or any other specified loading, the temperature of the filling medium (oil or air) shall not exceed 70ºC, with the cable conductors at a temperature of 90ºC and the external ambient at 40ºC; the effects of solar gain shall be taken into consideration.

Boxes/chambers shall: -

(i) Accommodate the fittings for cable termination, including stress-cones or other stress control devices.

(ii) In the event of an internal breakdown, they shall: -

(a) Not disintegrate

(b) Control emission of arc products safely (particularly with regards to personnel) and without penetration into the main tank.

Fixing studs/bolts for cover plates and flanges shall: -

(i) Be not less than M10,

(ii) Be spaced not more than 75mm between centres,

(iii) Not penetrate the casing. Where blind tapped holes are employed, studs shall be used; set screws and bolts are not permitted.

Flanges shall have: -

(i) A thickness of at least 4 mm,

(ii) Not less than 12 mm between the inner edge of the flange and the hole for the securing studs.

Cover plates shall: -

(i) Be separate and removable,

(ii) Have a thickness of not less than 5 mm,

(iii) Not exceed 25 kg in weight.

Gaskets shall be supplied, made in one piece from oil resisting synthetic rubber bonded cork, having: -

(i) An uncompressed thickness of not less than 5 mm,

(ii) An effective width on the inside of the fixing studs/bolts of not less than 12 mm,

Terminals shall be marked in a clear and permanent manner.

Provision shall be made for earthing the body of each cable box. Such earthing connections shall have a cross sectional area of not less than 125mm².

When an earthing transformer is to be connected to a primary transformer, and where the LV side of the said primary transformer is cable connected, then a separate cable box shall be included to facilitate the connection of the earthing transformer, the cable shall be 185mm², solid Al. conductor, EPR insulation triplex cable. The earthing transformer cable box shall be of an unfilled type and comply with the relevant applicable clauses in the relevant specification. The neutral of the earthing transformer shall be an external oil to air bushing to facilitate the connection of the earth tape to the EAT and not brought out via Euromold bushing in the EAT cable box unless otherwise specified.

The bushings for the earthing transformer cable box shall be 1250A separable bolted connectors to interface C bushings in accordance with EN 50181 for 36kV. Example Euromold type M400AR- 4

A supporting bracket shall be provided on the side of the transformer to support the 11kV triplex cable and pre-drilled to mount an Ellis Patent twin bolt fixing Atlas cable cleat. The Ellis Patent Atlas cable cleat shall be commensurate for the 185mm^2 solid aluminium conductor EPR cable required for the earthing transformer connection. Unless otherwise agreed, this bracket shall be mounted no more than 1 metre below the gland plate. The bracket shall be positioned in such a way that when the Atlas cable cleat is fitted, the cable shall pass through the centre of the cleat and enter straight into the base of the separable connector housing. The Ellis Patent, Atlas cable cleats will not be supplied with the transformer; they will be supplied under a separate contract.

UNFILLED CABLE ENCLOSURES / CABLE BOXES

General

The below table specify the details for unfilled enclosures cable boxes; the particular requirements, in accordance with the Schedule 1 will be specified by the main Contractor.

All transformers shall be provided with an LV disconnecting chamber where cable connection is specified in Appendix 1 at the time of tender.

A supporting bracket/s shall be provided on the side of the transformer to support the HV or LV cables and pre-drilled to mount Ellis Patent twin bolt fixing Atlas cable cleats. This bracket/s shall be capable of cleating one, two or three cable/s per phase. The Ellis Patent Atlas cable cleats shall be commensurate for the correct size of cable required for the transformer in question. Unless otherwise agreed, this bracket/s shall be mounted no more than 1 metre below the gland plate. The bracket/s shall be positioned in such a way that when the Atlas cable cleats are fitted, the cable/s shall pass through the centre of the cleat/s and enter straight into the base of the separable connector housing/s. The Ellis Patent, Atlas cable cleats will not be supplied with the transformer.

Details for 12kV Unfilled Enclosures

Transformer Rating	MVA	Up to 16	Above 16 up to 30	Above 30 up to 46	Above 46 up to 61
Number of Cable Boxes	Phases	3	6*	3	3
	Neutral	1	1	1	1
Maximum Cable Size, stranded copper or aluminium:- either Phases or Neutral	mm²	630	630	630	630
Bushing Rating		1250	1250	1250	1250
Poles per Box	Phases	1	1	3	4
	Neutral	1	1	1	1
Cables per Box	Phases	1	1	3	4
	Neutral	1	1	1	1
Glands per Box	Phases	1	1	3	4
	Neutral	1	1	1	1
Drawing Number (Phase and Neutral)		Fig 1	Fig 1	Fig 1	Fig 1

[#] The arrangement drawing shown in figure 1 is a typical general arrangement, the dimensions for the cable box shall be commensurate to fit the Cenelec interface C outer cone bushing shown in drawing and the pictures shown below.

Equipment shall be capable of withstanding the prospective fault currents specified by the main Contractor selected from one of the ratings below.

Table of phase to earth short-circuit current withstand capabilities for cable boxes.

Voltage kV	kA (rms) for 3 seconds
36	25, 31.5
11	21

Any additional insulation for conductor fittings required for cable boxes up to 36kV, will be provided by the purchaser.

Where phase isolation is specified, single-phase boxes shall be used.

Unless otherwise specified, cable entries shall be vertical from below.

Where condenser bushings are specified in the Schedule they shall be in accordance with BS 2562, Fig. 15.

Each cable shall be provided with an individual removable split gland plate. Gland plates for single-core cables shall be manufactured from non-magnetic material.

Unfilled Enclosures

Enclosures shall comply with the requirements of BS 6435 except where modified by this Section.

Enclosures incorporating separable bolted connectors shall be equipped with interface C bushings in accordance with EN 50181 for 36kV. Bushing eg Euromold type M400AR-4.

Compression type cable glands will be supplied by the Purchaser.

Enclosures shall incorporate:-

(i) Two 100 x 100mm holes double louvered, with gauze sandwiched between the two louvers, 25mm up from the gland base plate, one on each side of the cable box for breathing.

(ii) Two 12mm holes in the base for drainage.

The protection shall also prevent the insertion of any object liable to cause a dangerous occurrence.

Enclosures shall be provided with an accessible earth terminal, near the base. This terminal shall comprise a screwed rod of phosphor bronze or high tensile brass having a minimum size of M12 x 65 mm long, passing through the shell and secured on each side by a plain washer and one full nut. It shall also be provided with two plain washers and two locknuts, both inside and outside the enclosure.

Unfilled Enclosures 12 kV

Enclosures shall be dimensioned to be suitable for -

(i) These Outer Cone bolted separable connectors bushings, shall be designed to EN 50181 for 36kV and shall be of the interface C type and shall be capable of having a 1250A rating, e.g. Euromold type M400AR - 4, or as otherwise agreed at time of Tender.

(ii) Depending on the rating of the transformer the cable box and bushings shall be suitable for one cable per phase, two cables per phase or three cables per phase. If three cables per phase are required then there shall be an individual outer cone bushing for each cable, see below. The outer cone bushings shall be spaced to ensure that bushing extenders are not required. The requirement for bushing extenders shall not be required from the design of the transformer.

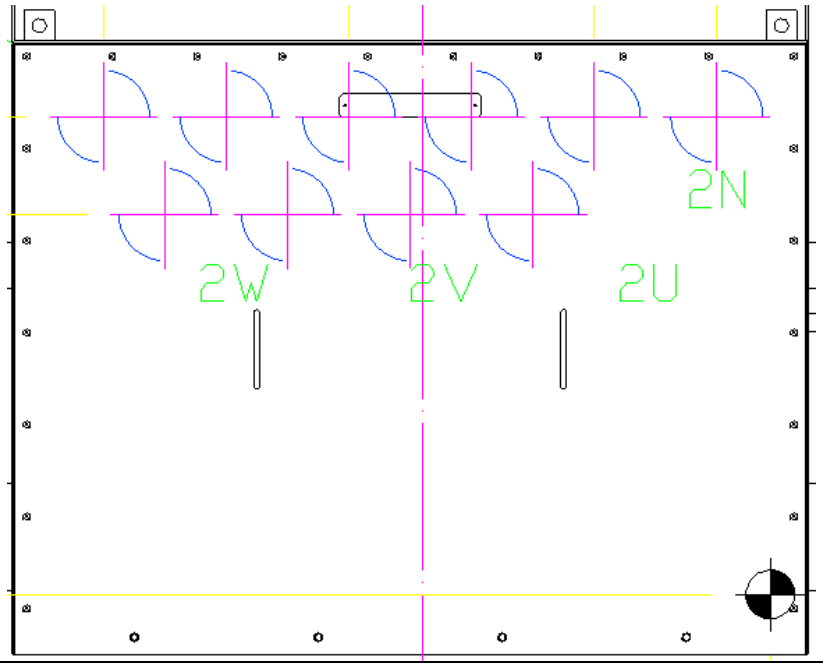
Unfilled Enclosures for 36 kV

Shall be provided. Where phase isolation is required, a separate cable box/enclosure for each phase, which may terminate more than one cable, shall be provided.

Enclosures shall be dimensioned to be suitable for -

(i) These Outer Cone bolted separable connectors, shall be designed to EN 50181 for 36kV and shall be of the interface C type and shall be capable of having a 1250A rating, Euromold type M400AR - 4, or as otherwise agreed at time of Tender.

(ii) Depending on the rating of the transformer the cable box and bushings shall be suitable for one cable per phase, two cables per phase or three cables per phase. If three cables per phase are required then there shall be an individual outer cone bushing for each cable, see pictures below. Design of the transformer shall mean that there isn't a requirement for bushing extenders.



Typical 11 or 33kV Outer cone separable connectors 3 cable per phase cable box.

Three cables per phase showing the configuration of the equipment interface bushings (M)400AR-4, utilizing the single cable arrangement shown previously. Each (M)400AR-4 shall be fitted in such a way so as to not interfere with the adjacent separable connector or require the use of stand-off bushings. The layout of the bushings in the cable box shall be similar to that shown by the red crosses in the sketch above.

INNER CONE SEPARABLE CONNECTOR CHAMBERS

General

Cable connected transformers/reactors having voltage ratings of 66 kV and above, shall have their cables terminated using inner cone Pfisterer Size 5S separable connectors the separable connectors shall have individual phase chambers.

Where inner cone separable connectors are fitted to transformers/reactors rated 20MVA and above, a disconnecting chamber shall be provided. Both inner cone separable connector chambers and disconnecting chambers shall be of phase isolated design.

The inner cone separable connector chambers shall be filled with insulating oil complying with the requirements of this specification. The oil level shall be maintained from the main conservator by means of a connecting pipe of 25 mm diameter to the highest point in the chamber. This connection shall be controlled by a suitable valve, and shall ensure that any gas leaving the chamber will pass through the gas and oil actuated relay specified. A barrier shall be provided on both sides of the disconnecting chamber to prevent oil used for filling the chamber from entering the cable box or from communicating with the oil in the transformer/reactor, other than through the equalising pipework to the conservator. It shall be necessary to remove only part of the oil in the chamber itself when making the necessary testing connections.

An approved drain/filter valve shall be provided at the lowest point and a filter valve shall be fitted at the top of the chamber.

Each chamber shall have two Pfisterer size 5S inner cone separable connectors, one connector shall be installed in the upward direction and the other in the downward direction. The incoming cable entries shall be vertical from below; the upper inner cone connector shall be voltage-proof sealed with a dummy connector.

The inner cone separable connector chambers and associated disconnecting chambers shall permit either the transformer/reactor or the cable to be subjected to the high voltage test specified in their own Contract documents. The upper inner cone connector provides for mounting a temporary bushing for this purpose. Subject to the approval of the Purchaser, it will be permissible to use such a bushing for factory tests on the transformer/reactor in lieu of the cable.

When required by the Purchaser, inner cone separable connectors and their associated chambers shall be tested in accordance with the relevant clauses of IEC 60840 and DIN VDE 0276 05.

The inner cone separable connectors, bushings and their mounting arrangements shall withstand the thermal and dynamic effects of short-circuit currents of the associated transformer/reactor, as specified in IEC 60076.

Cabling and jointing within the inner cone separable connector chambers will be carried out under a separate contract.

15.3.3 Outdoor bushings

Bushings shall be to pollution class IV of IEC 60815 with a minimum creepage of 31.5mm / kV.

As noted above, brackets for mounting surge arresters are required.

HV terminals shall be arranged so that the connections can be taken away horizontally.

Facilities to release air trapped during transformer/reactor assembly, with the minimum dismantling of component parts, shall be provided.

15.3.4 Unit auxiliary transformer

The Schedule in Appendix 1 will state if a separate, ground mounted auxiliary / earthing transformer is required. If so, requirements for these are specified in WPD EE 142.

15.4 On-Load Tap-changer

Tap-changers shall also comply with IEC 60214-1

Tap changing equipment shall be suitable for full bi-directional power flow.

Internal type (oil environment) tap-changers shall be of vacuum diverter switch design and arranged such that the diverter contacts are not immersed in the transformer main tank oil.

Internal type tap changers may be "externally mounted" by the use of a separate enclosure and an oil-tight barrier board designed to separate the oil surrounding the tap selector contacts from the transformer tank oil.

The tap-changer make and type shall be approved by WPD prior to order of the transformer.

Mechanism enclosures shall be protected to EN 60529, Class IP54. On load tap change equipment driving mechanisms containing 400V connections shall be provided with an approved danger notice.

It shall not be possible for the oil in diverter-switch or selector-switch compartments to mix with oil in the transformer tank or any other compartments. Oil in the tap selector compartment shall be maintained under oil head by means of a pipe connection from the highest point of the compartment to the conservator pipework. A valve, complying with the requirements of 13.6.8 shall be fitted at the exit from the tap selector compartment and a gas and oil actuated relay, complying with the requirements of 13.6.3. Shall be provided as close as practicable to this valve. Where duplicate outlets from the tap selector compartment are provided, the valve and the gas and oil actuated relay shall be fitted as close as practicable to the common point, on the conservator side. Where the tap changing equipment comprises phase isolated tap selectors, these requirements shall apply for each phase.

Oil sampling pipes shall be included in the tapchanger design to reduce the need to remove the lid to sample the oil from the tapchanger pocket.

The oil surge relay fitted shall have a nominal flow rate of greater than 1.2m/s to prevent unwanted trips.

The nominal resistance of diverter resistors shall be inscribed on the tap changer rating plate.

15.4.2 Segregation of Compartments

All types of tap-changer, including those with vacuum diverter switches, shall be provided with a separate tap-change conservator fitted with an oil level gauge.

A maintenance free de-hydrating breather shall be provided. To facilitate replacement or servicing, the breather shall be mounted at approximately 1400mm above ground level. De-hydrating breathers having a total weight greater than 10kg shall be supported separately from the breather pipe. When necessary the breather pipe shall be braced for stability. The unit shall be self-monitoring and a voltage free changeover contact for alarm condition provided (2A at 230V AC/DC)

A weatherproof and air-tight oil filling pipe, brought down to ground level and fitted with a non-return DN25 (minimum) valve at its termination shall be provided.

Drainage facilities, brought down to ground level, fitted with DN25 (minimum) valves adjacent to the conservator and at its termination shall be provided.

15.4.3 Method of operation

Electrical Control - on-load tap-change equipment

General Requirements

All on-load tap change equipment shall be provided with facilities for local and remote electrical control. These facilities shall permit extension for independent automatic or group parallel automatic operation from the control source. The form of electrical control required is a circulating current scheme typically as shown in Fig 6 Drawing EM1 which is based on use of the MR Vacutap tap---changer. The latest WPD drawings will be issued at the time of tender.

The electrical control circuits for each primary unit shall operate at 110 volts ac, single phase, derived from a control circuit transformer (CCT), which shall comply with the requirement of EN60742, having a ratio of 240/55-0-55 volts, with the centre point of the secondary winding earthed through a bolted link. The incoming connections to the transformer shall be supplied with a fuse (or MCB) and a neutral link. The outgoing connections shall be supplied with a fuse (or MCB) in each pole. This transformer, with its fuses and links, shall be mounted in the marshalling kiosk or cubicle, as applicable. MCBs shall be lockable to provide isolation. Fuses shall be Red Spot.

All motor contactors and their associated control apparatus and indicating devices shall function correctly over the range of voltages, frequencies loads and durations specified.

It shall not be possible for more than one electrical control point to be in operation at any time except when voltage reduction facilities for load reduction at a REMOTE CONTROL panel are required for Independent automatic and Group Parallel automatic control.

The electrical control shall be provided with a directional sequence switch (DSS) integral with the driving mechanism (DM) to ensure that when a tap change operation has commenced it shall be completed independently of the operation of control switches or relays. If failure of the operating supply should occur during a tap change operation, the driving mechanism shall complete its operation when the supply is restored.

Directional raise and lower end stop limit switches (DRLS and DLLS), to prevent operation of the driving mechanism beyond the end positions, shall isolate the motor supply and the motor control circuit. The arrangement of these limit switches shall permit electrical operation in the opposite direction; these switches shall automatically reclose when the mechanism moves from such an end position.

Facilities shall be provided to isolate the incoming ac tap-changer supply at each marshalling kiosk or cubicle by means of a three-position LOCAL/OFF/REMOTE local selector switch (LSS). This switch shall be capable of being padlocked in the OFF position. The two remaining positions of the local selector switch, complete with the necessary contacts, shall be available to permit extension, without alteration, for other forms of control.

When REMOTE CONTROL facilities are specified in the Schedule, either of the following alternatives shall be provided for each transformer or reactor, and specified at time of tender.

(i) a separate panel having a layout typically in accordance with WPD drawings

or

(ii) As loose items for mounting in general control panels by another Contractor.

or

(iii) The remote panel will be provided complete under a separate contract.

For any CT information please see appendix 6.The dimensions for the current transformer shall fit within the accommodation detailed in the Schedule. This current transformer shall be capable of carrying 150% transformer rated current continuously.

Local/Remote Control

Circuits and arrangements for local and remote control of on-load tap change equipment shall comply, as applicable, with the schematic diagrams, supplied with each tender.

Facilities shall be provided at the local position and remote position to enable the tap-changer position number to be raised or lowered. The controllers shall be clearly inscribed to indicate their purpose; typical examples are: 'RAISE TAP POSITION NUMBER' and 'LOWER TAP POSITION NUMBER'.

A raise of tap position shall be a raise in number i.e. **Tap position 1 to tap position 2** this will mean a decrease in HV voltage.

A lower in the tap position shall be a lower in number i.e. **Tap position 19 to tap position 18** this will mean an increase in HV voltage.

Both of these will allow WPD to maintain LV voltage as per our AVC schemes.

The controller at the marshalling kiosk or cubicle shall be operative only when its associated LOCAL/OFF/REMOTE local selector switch at the marshalling kiosk or cubicle is set to LOCAL. Under this condition, all other control points shall be inoperative.

The tapchange control cubicle shall be positioned as to facilitate ease of operation, where flood requirements mean mounting the control box high up on the transformer then provision of steps is required, the design of these steps needs to be approved by WPD policy and design.

The remote control panel shall be provided with a three position panel selector switch (PSS):

Position 1: HAND

Position 2: AUTO

Position 3: PARALLEL

The controller at the remote control panel shall be operative only when its associated LOCAL/OFF/REMOTE local selector switch at the marshalling kiosk or cubicle is set to REMOTE and the selector switch at the remote control panel is set to HAND. Under these conditions, all other control points shall be inoperative.

Electrical operation initiated by any controller shall cause one tap movement only unless the controller is released between successive changes.

All local and remote operating switches for the tapchanger control cubicle supplied by the tapchange manufacturer need to be contained in the control cubicle and not be accessible from the cover.

The manual cranking handle needs to be contained in the control cubicle supplied by the tapchange manufacturer and not stored on the external side of the cubicle.

15.5 Clearances to exposed conductors

The minimum clearance between live metal to any oil pipework, coolers,
s and pressure relief devices shall be -

Highest voltage for equipment (kV)		
33	66	132
500mm	864mm	1300mm

If these clearances cannot be obtained they can be reduced to those given in Table 10 – External Air Clearances of ENATS 35-3 providing the oil pipework etc. is adequately shielded to give protection from arc damage. Such shielding shall comprise a 6mm thick mild steel plate located to avoid fault currents passing through fittings. The shield shall be bonded by a separate connection to an earthing terminal and no reliance placed on fortuitous earthing via gasketed joints.

15.6 Fittings

15.6.1 Conservator

The conservator shall have a capacity between highest and lowest indicated oil levels of not less than 7.5% of the total oil volume (including tap changer tap-selector and cooling equipment) at 15°C.

The conservator(s) shall be positioned not to obstruct the incoming and outgoing electrical connections the preferred location is on the cooler bank to prevent clearance issues and further difficulties when a noise enclosure is to be erected. The conservator should be positioned with pipework to allow topping up from the ground ideally while the transformer is still live. The conservator shall be fitted to prevent over hang the bund wall and to prevent interference of the erecting of a noise housing.

The removable end cover shall be complete with integral lifting lugs.

The valve referred to in Clause 15.6.1 (e) of ENATS 35-3 shall be of the non-return type and the oil filling pipe shall enter the conservator above the oil level.

15.6.2 Cooling plant

Cooling banks alone shall be capable of dissipating the total losses at CMR and when operating at any loading within the normal loading cycle.

Provision shall be made to mount the separate cooler bank at either end of the tank without modifications to the transformer and the additional valves and blanking plates specified in 15.6.2 shall be provided.

Transformers rated at 30 MVA and above having natural and forced cooling shall, unless tank attached coolers are specified, have radiator banks on free standing frames with the cooling equipment and separate from the main tank.

Cooling plant shall be designed so that all painted surfaces can be thoroughly cleaned in situ and subsequently repainted by suitable brushes or sprays.

The design of cooling plant shall ensure that pockets of gas do not accumulate internally, or water collect externally.

Pipework shall be provided for connecting each transformer/reactor tank to its cooling plant. Cast iron shall not be used. Oil piping shall be provided with flanged joints.

It should be noted that as provision for fitment of a sound attenuation enclosure has been specified, duplicated expansion joints are required as specified in clause 13.1 (iii) of ENATS 35-3. Such devices shall be capable of withstanding the stresses likely to be encountered during installation, service and maintenance. Where such devices are of thin-wall construction (less than 1.7 mm) and within 2 metres of plinth level, they shall be provided with mechanical protection.

Fans shall be supported from the cooler bank structure and incorporate an approved form of anti-vibration mounting. It shall be possible to remove any fan, complete with its motor, without disturbing or dismantling any part of the cooling bank structure.

Fan cowlings and steel fan supporting "spiders" shall be galvanised. Galvanised wire-mesh guards shall be provided to prevent accidental contact with the blades of the fans. Protective guards shall also be provided over all moving shafts and couplings. These guards shall be designed and manufactured to ensure compliance with EN 60526 class IP3 or as otherwise agreed.

Oil circulating pumps shall be accessible and supported without the need for separate foundation fixings. Housings of pumps and their motors shall incorporate plugs for air release and oil drainage.

The electrical control of oil circulating pumps and cooling fans shall be in accordance with the relevant WPD drawings supplied at the time of tender.

All transformers and reactors having mixed cooling shall be provided with facilities for selection of AUTOMATIC or MANUAL control of the cooling plant. These control facilities shall be located at the marshaling kiosk (MK) or at a cubicle associated with the cooling plant.

Each fan and oil circulating pump motor circuit shall include a three phase overload and single phasing protection relay (FMPR or PMPR), fitted with hand reset and trip indication facilities and having a dust protecting case, mounted in the marshaling kiosk or cubicle. This relay shall be capable of carrying the motor starting current without tripping when its trip setting is 115% of rated full load current of the motor.

The Motor contactors shall comply with the requirements of EN 60947.

Circuits and control arrangements for automatic electrical and manual (testing) electrical control of cooling equipment of mixed cooled transformers and reactors shall comply with WPD latest revision of drawings

Automatic starting and stopping of the cooler motors shall be controlled by winding temperature indicators.

Where the transformer cooling design requires a pump two will be supplied to mitigate against a single pump failure, it shall only be possible to start the pump motors in sequence. To achieve this, a sequence starting scheme shall be inter-connected between the motor contactors (PMC) of each pump.

A multi-position cooler control switch (CCS) shall be mounted in the marshaling kiosk or cubicle, shall provide for automatic control and operational checking of:

(i) Each fan or group of fans,

(ii) Each pump

(iii) Fans and pumps

The temperature indicators shall control the operation of the cooling plant motors automatically when the associated cooler control switch is set for AUTOMATIC.

Each motor circuit or, as applicable, group of fan motor circuits, shall be provided with back-up protection of the motor protection relays by suitably rated fuses or miniature circuit breakers (MCB) mounted in the marshaling kiosk or cubicle.

Facilities shall be provided in the marshaling kiosk or cubicle to enable the cooling plant motors to be isolated by means of an ON/OFF switch. This switch shall have auxiliary contacts arranged to close after, and open before, the main contacts, and suitably inter-connected with the contactor coil circuits to enable the normal switching duty to be performed by the fan and pump motor contactors.

15.6.3 Gas and Oil Actuated Relay

Each conservator oil feed pipe shall be fitted with an approved design of gas-and-oil actuated relay having alarm contacts which close on collection of gas and low oil level, and tripping contacts which close following oil surge and low oil level (double element type). The alarm and trip functions shall not be operated by hollow floats. All sampling and drain points need to be brought down to ground level to allow access from the ground.

Relays shall be provided with two visible scales, one each side, calibrated in increments of 100 cc up to 400 cc, or as otherwise agreed, to provide indication of gas collection. These devices need to be able to be tested from ground through injection as well as test via plunger.

15.6.4 Pressure Relief Device

Pressure relief devices shall be located so that their function is not inhibited by operation of isolating valve(s). These devices shall be fitted as to prevent the reset button being inadvertently operated and covered with a suitable cover to prevent this operation other than under fault conditions.

Pressure relief devices shall be provided with means to:-

(i) Prevent the ingress of rain or snow into any part.

(ii) Prevent continued oil flow from the transformer following operation to relieve internal pressure.

Spring operated, self-sealing devices shall:-

(iv) be capable of withstanding a full vacuum,

(v) have a hand hole giving access to the tripping and reset lever. The outer end of the pipework is to be protected from ingress of vermin etc. by a grid; paint spray or ice formation shall not seal the outlet. Any bends shall have a radius of the central axis of the bend not less than the equivalent pipe diameter.

15.6.5 Winding Temperature Indicators

Each transformer shall be provided with an approved device indicating the maximum winding temperature) a winding temperature indicator and associated current transformer. The winding temperature indicator shall be of an electronic design for example the Ashridge 852 116. Programming of any hard programmed items for any other use is not permitted due to the risk of trip associated with these functions.

Means shall be provided, external to the winding temperature indicator case, for checking the operation and setting of the contacts Means shall be provided with facilities to prevent unauthorized interference. The temperature indicator shall have a range of 30°C to 150°C. The design of the indicators, the components contained therein, any capillaries and their connections, other associated equipment and the mounting arrangements shall be such that the equipment will not sustain damage or mal-operation due to vibration in service. Anti-vibration mountings shall preferably be integral with the indicator case.

The indicator shall have three sets of independently adjustable contacts having the following purpose and characteristics:

(i) Cooler Control
Adjustable setting 50°C to 100°C (5°C maximum steps)
Adjustable differential 15°C to 30°C

(ii) Alarm
Adjustable setting 80°C to 150°C (5°C maximum steps)
Fixed differential of not more than 10°C

(iii) Trip
Adjustable setting 80°C to 150°C (5°C maximum steps)
Fixed differential of not more than 10°C

Dial type indicators shall have contacts that are adjustable to a scale and that are accessible on removal of the cover.

The winding temperature indicator shall be arranged to replicate the “hottest” winding.

15.6.6 Current transformers

The current transformers providing winding temperature indication, as detailed in Item 26 of Appendix 1, shall be located under the main tank cover, accessible via a cover plate. Separate Test bushings shall be provided to facilitate primary injection testing, these test bushings shall be housed in a separate box to all other CT wiring.

A current transformer for voltage compounding, as detailed in Clause 15.4.3 of this specification, shall be provided.

The standard current transformers for protection and measurement shall be provided as per drawings listed in appendix 6 this shows the location of the CT compared to the windings and its use. Site specific CT details if required will be identified at time of tender.

15.6.7 Other fittings

All oil containing parts liable to entrap air shall be fitted at their highest points with an air release plug to permit release of any air trapped following oil filling.

A valve shall be provided on the tank at each point provided for connection to separate radiators or coolers (ie both ends of the tank). Where cooler pipes enter the tank cover vertically, such valves may be at the cooler headers. For any design where the inlet or outlet arrangement at the tank consists of a single pipe, an additional valve shall be provided in each branch pipe to the coolers.

Tank attached radiators shall be provided with isolating valves.

A valve shall be provided in the main oil connections at the bottom of each cooler when oil circulating pumps are fitted, to allow removal of the pump without draining oil from the transformer or cooler.

A 50mm valve shall be provided in the oil feed pipe to each tap selector compartment positioned to permit maintenance of the tap selectors

A 15mm isolating valve shall be provided in any equalising pipe arranged between tap changer selector compartments and main tank to facilitate oil draining for maintenance of tap selectors.

For transformers and reactors having oil quantities exceeding 18,000 litres, a valve of minimum size 80 mm shall be provided together with such arrangements as may be necessary within the tank to ensure that the tank can be drained of oil as far as is practicable.

A 50mm valve shall be provided at the top of each oil-filled cable sealing or disconnecting chamber for 66kV and above.

Plugs shall be provided to permit as far as is practicable, drainage of detachable radiators, whether connected directly to the tank or to cooler headers.

Plugs shall be provided to permit effective drainage of oil from circulating pumps, and gas and oil actuated relays.

If specified in Schedule 1 all filter valves and combined drain and filter valves shall be fitted with flexible hose adapters, provided with suitable gaskets and caps of the size specified in accordance with Fig7 attached.

Tank attached radiators, shall be detachable and provided with flanges for the inlet and outlet connections. Valves of an approved type shall be provided at each point of connection to the tank of power transformers and reactors. Plugs shall be provided at the top and bottom of each radiator for air release and oil draining purposes. Where a transformer is provided with cable connections, the arrangement of such radiators shall give unrestricted access for the cables when rising vertically from below.

15.7 Thompson Strap

Transformers with double delta 11kV secondary windings shall be fitted with a Thompson Strap connection used to link the “c” phase windings. The strap shall be accessible by the removal of a suitably labeled bolted cover in the lid of the transformer and storage facilities for the strap when not in use shall be provided in the same compartment. The transformer nameplate should indicate if the strap is connected or not connected at time of dispatch. The Thompson strap shall be rated to carry full LV current continuously.

A continuity test shall be completed and a visual inspection of the chamber to prove that the strap is fitted.

15.8 Marshalling and / or Control Box

Common Requirements for electrical control and marshalling.

Contacts and other parts which may require renewal, adjustment or inspection shall be readily accessible.

All hand operated electrical control switches shall be clearly labeled and inscribed, as applicable, to indicate the function of the apparatus with which they are associated.

The OFF position for switches shall be lockable, with rotation to ON.

Contacts and current carrying parts associated with motor circuits shall be capable of making, breaking and carrying, as applicable, the starting and stalled current of the motor(s).

Vibration in service however caused, shall not result in mal-operation of switches contained in protective devices eg gas and oil actuated relays, or of oil flow indicators, temperature indicating devices, relays, instruments etc.

Control, protection and wiring arrangements shall be in accordance with ENA Technical Specification 50-18 unless otherwise agreed with the Purchaser.

All protection, monitoring and control facilities shall be wired out within the relevant panel to provided alarms and indications as specified in the Schedule and shown on detailed diagrams listed in the Schedule. All cabling from the transformer to remote equipment (ie outside the transformer bund) shall be terminated in the free standing marshalling kiosk (MK) or Marshalling Cubicle (MC).

15.8.1 General Requirements

The following definitions apply:-

(a) Marshalling kiosk (MK) - a free-standing enclosure,

(b) Marshalling cubicle (MC) - an enclosure fixed either to the separate cooler, where provided, or to the transformer/reactor.

Requirements for either a MK or a MC are specified in Appendix 1.

Unless otherwise agreed prior to contract Marshalling Kiosks shall be arranged to provide 1 metre resilience to flooding, but not have overall height of more than 2.0 metres. Equipment shall be housed in separate compartments as follows:-

(i) Temperature indicators and their ancillaries

(ii) Cooler control

(iii) On-load tap changer control

(iv) Interposing CTs

(v) Terminals and cable glands

The construction and mounting arrangement of MK/MCs shall:-

(i) be weatherproof, and have a rating of IP55 to EN60529,

(ii) prevent the retention of water externally,

(iii) be proofed against vermin,

(iv) be ventilated and heated to prevent condensation.

Proposed materials for the construction of walls, sides, covers and doors; shall be subject to approval. Galvanised mountings shall be provided.

Cables shall enter from the bottom, and removable gland plates shall be provided at not less than 460 mm from plinth level.

Glands, gland plates and cable compartments shall be adequately sealed to prevent moisture entering other compartments.

Divisions between internal compartments shall be of steel, securely fixed in position, and arranged to permit natural air circulation.

Two lifting lugs shall be provided at diagonally opposite corners.

All compartments shall have both front and rear hinged doors with the following exceptions unless otherwise agreed:-

(i) the cable compartment of MKs shall have no front door,

(ii) the interposing current transformer compartment shall have no rear door.

Doors shall comply with the following requirements:-

(i) have oil and weather resisting gaskets arranged to create a labyrinth seal against the compartment flange,

(ii) open through approximately 180°

(iii) have integral 'stay-bars' for positive location at approximately 90°,

(iv) be fastened by integral handles; nuts, bolts or carriage keys shall not be used,

(vi) Have external fittings that are of suitably durable, non-corroding materials.

Provision shall be made for padlocking. The padlock will have a shackle of 7 mm diameter, a shackle height of 20 mm and radius of 8 mm. Other forms of locking are not acceptable. Handles and padlocking facilities shall be not be more than 1525 mm above plinth level.

Individual components shall be easily removable without disturbing other apparatus or wiring.

15.8.2 Terminals, and Ferruling

Terminal blocks shall be angled towards the appropriate doorway to assist access and visibility, arranged as follows:-

Cables and cores shall be numbered in accordance with a schematic diagram or multicore schedule provided by the purchaser.

Terminal boards shall be Klippon type RSF1 except for telecontrols which shall be type SAKR. If space is a premium consideration shall be given to the use of RSF3 terminals, but all AC supplies shall be RSF1. Alternative makes of similar type terminals may be approved at the time of tender providing full details (incl. samples) are provided at the time of tender.

15.8.3 Earthing

A 25 x 3 mm copper bar, mounted on stand-off insulators, shall form the ring circuit earth (RCE) inside the MK/MC, entering all compartments. A steel boss or bar shall pass through, and be welded to, the side wall of the cable compartment to permit connection to the RCE internally and to the substation earth externally.

Each metal case of apparatus mounted in MK/MCs shall be connected to the RCE by an insulated wire, coloured green / yellow.

The mid-point of secondary windings of control circuit transformers shall be earthed through a removable bolted link to the RCE.

Ventilation and Heating

An approved type of 230 volt, metalclad, anti-condensation, heater(s) shall be provided. The heater shall be protected by a fuse and neutral link, and controlled by a weatherproof, single pole, ironclad, rotary switch, mounted on the outside. The surface temperature of heaters shall not exceed 65°C.

Ventilation louvres shall be provided near the top and bottom on the sides of MK/MC.

15.8.4 Fittings - General

Unless otherwise specified in the Schedule the MK/MC shall be fitted with an externally mounted switched socket outlet, comprising:-

> 1 - 13 amp 3 pin British Standard switched socket with 30mA residual current device for 240 V ac supply. This switched socket is to be connected to the kiosk heater supply circuit through a fuse in the "live" lead and a link in the neutral lead.

Labels shall be provided for all apparatus mounted inside and outside MK/MCs and, to identify the compartments, on outside of doors.

Where 230 volt, phase to neutral, connections are taken into MK/MCs, "400 VOLT DANGER" notices must be affixed to the outsides of the doors of the appropriate compartments.

Connections and wire numbers for the switched socket, heaters, shall be in accordance with Drawing Nos SPC 206 and SPC 207 for WPD Midlands and SWest and Drgs PSD0802-2 and PSD0803 for WPD SWales.

Elements of three phase relays, contactors, isolating switches, supply fuses and thermal devices, shall be marked with the appropriate phase colour.

15.8.5 Labels

All marshalling kiosks or cubicles shall be provided with appropriate labels of durable, rigid material for all internal components.

Labels bearing an appropriate legend shall be fixed to all terminal blocks. The legend shall be clear and concise to indicate the function of groups of terminals and shall have upper and lower case letters, the upper case height being 3 mm.

Labels provided for all apparatus such as relays, switches, fuses etc, contained in any marshalling kiosk or cubicle and REMOTE CONTROL panel shall be so placed that there can be no ambiguity as to the apparatus or equipment to which they refer.

All labels fitted inside marshalling kiosks or cubicles and inside and outside STANDBY CONTROL panels shall be secured with non-corrodible screws or rivets.

Labels fitted to apparatus at the back of panels shall be fixed so that they are not coverable by wiring. They shall not be attached to removable covers.

15.8.6 TERMINAL HOUSINGS (other than MK/MCs)

Housings shall be of durable materials, of rigid construction and free from distortion.

Each housing shall be provided with a cover which can be easily removed and replaced, to provide access to terminations. Covers exceeding 15 kg in weight shall be fitted with hinges.

Housings shall be mounted with their covers in the vertical or near vertical plane. They shall be provided with suitable cowled ventilation.

Housings shall be weatherproof and not allow water to collect on any surface. The top of fabricated housings shall be sloped to shed water away from the cover.

Terminals and their connections shall be easily accessible from the front of the housing.

The fixing of terminals and terminal boards within housings, shall be independent from fixings for the housings.

Housings which are not welded to structures shall be fitted with an external earth terminal stud which shall not penetrate the housing.

15.8.7 CONNECTIONS AND WIRING

General Requirements

Insulated wires shall comply with BS 6231/HD 21. Due consideration shall be given to requirements for fuse grading, current rating, voltage-drop, mechanical strength and terminations.

Fuses shall be Red Spot and comply with the requirements of EN 60269 and application shall be in accordance with ENA Technical Specification 50-18.

MCBs shall comply with the requirements of EN 60947. Application of MCBs shall follow the general principles of ENA Technical Specification 50-18 as applied to fuses. MCBs shall be lockable to provide isolation.

Terminals, terminations and wiring identification shall comply with the requirements of ENATS 50-18

15.9 Interconnecting Cables

The supplier shall provide, for approval by the Purchaser, a schedule detailing the multi-core cables, to be supplied under the Contract, for interconnection of ancillary equipment.

External cabling between the transformer fittings and the marshalling kiosk/cubicle, shall consist of PVC-insulated and sheathed steel wire armored cable with PVC overall.

External cables shall be adequately fixed to galvanized cable trays using cleats or saddles or other approved methods of. Routing through oil containment walls is prohibited.

Cables passing through sound attenuation enclosure noise enclosure walls shall be grouped together. A removable panel of weak mix cement, will be provided.

WPDs preference unless specified in Appendix 1 is for a Marshalling cubicle transformer mounted.

15.10 Magnetic Circuit

The maximum flux density in the limbs any part of the magnetic circuit for any tap position, with rated voltage between terminals, shall not exceed 1.65 Tesla under normal excitation condition.

16.0 DOCUMENTATION

Clause 16 of ENA Technical Specification 35-3 applies with the following additions –

16.1 Drawings

Tenderers shall provide with their tender, the following drawings -

(i) A preliminary outline showing side and end elevations and plan of the equipment offered, including indications of tap changer, terminations, cooling equipment, parts to be removed for transport and principle dimensions.

(ii) A typical arrangement of the tapchanger showing external clearance and any lifting apparatus necessary to undertake maintenance.

The drawings listed in 16.1 together with those additional drawings listed below, shall be provided for comment by the date specified in the Schedule, which shall be prior to commencement of manufacture. **Drawings shall** be provided for comment 10 weeks after the issue of notification of award and purchase order.

(i) A general arrangement comprising: HV and LV side elevations, end elevations and plan, indicating, as appropriate, the following items

- centre lines of pipe-work and turrets, etc., (with respect to the longitudinal and transverse centre lines of the tank in the plan view, and from plinth level in the elevation views) which pass through the sound attenuation enclosure walls and roof,
- parts to be removed for transport
- boundary lines depicting the sound attenuation enclosure
- the principal dimensions, including clearances required for tapchanger maintenance
- the transport dimensions

(ii) General arrangement of Marshalling Kiosk/Cubicle

(iii) Name, Rating and Diagram Plate and diagram of connections of transformer/reactor and associated equipment indicating the relative positions of connections and terminations

(iv) Schematic diagrams, as applicable, of:-

(a) tap change control,

(b) tap changer driving mechanism,

(c) cooler control,

(d) Marshalling kiosk/cubicle,

(e) Remote Control Panel.

(v) Details and connection diagrams of Winding Temperature Indicator (WTI) alarm, trip and cooler control arrangements, Protection CT Scheme Connections

(vi) Details of oil coolers, as applicable,

(vi) Valve function plate,

16.2 Assembly, Operating and Maintenance Instructions

One month PRIOR to delivery, the Contractor shall submit, for approval by the Purchaser, Assembly, Operating and Maintenance Instructions, and Diagrams. After approval, but not later than one month before the commencement of the maintenance period, the Contractor shall supply, in a durable form, the number of copies specified under the Schedule These shall include operation and maintenance instructions for tapchanger, r breather, gas and oil relays, temperature instruments and oil filled bushings.

These instructions and drawings shall include information necessary to form the health and safety file for the equipment, in accordance with the requirements of the Construction (Design and Management) Regulations 1994. The file shall include relevant material safety data under Control of Substances Hazardous to Health legislation.

16.3 Test Certificate

Three paper copies of test certificates shall be provided, together with a .pdf format Acrobat electronic copy.

17.0 TRANSPORT AND ERECTION

17.1 TRANSPORT

The Contractor shall be responsible for arranging transport to site and for ensuring the equipment is delivered to site fit for storage, service or normal future transport.

The costs of transport shall be included in the Tender.

'Datum centre lines' and 'the centre of gravity' shall be clearly and permanently marked on each side and each end of the tank.

Where no transport limitation exists, the transformer/reactor shall be transported complete with tap changer. Tap changing equipment shall not be removed from the transformer/reactor for transport unless specifically approved in writing by the Purchaser.

Filling medium conditions for transport, and whilst awaiting site assembly, shall comply with one of the following:-

- be completely oil filled,
- be allowed to breathe to atmosphere via a breather (equivalent to the in-service breather) provided that the windings and insulations are fully immersed in oil within seven days from factory draining.
- be pressurised by dry air or dry nitrogen provided the pressure is checked monthly to ensure that it does not fall below 35mbar gauge, and the windings and insulations are wholly immersed in oil within three months of factory draining. Where this method is adopted, pressure gauges having a full scale reading not exceeding 500mbar must be fitted. During such time the diverter switch tank of on-load tap changers shall be filled with oil, as for service.

17.2 ERECTION

The transformer shall be erected in accordance with the relevant drawings and include the positioning of anti-vibration pads.

Ferrous bolt threads on all equipment external to the transformer/reactor tank shall be greased before erection.

All pipe-work shall be checked for cleanliness before erection.

The Contractor shall be responsible for cutting any fixing holes that are required in the prepared foundations on site eg for separate cooler banks and for undertaking fixing down and providing all necessary fixing materials.

Transformers transported filled with nitrogen must be purged with dry air before permitting personnel to fit associated internal accessories.

Transformers which have been transported filled with dry air or dry nitrogen shall have their windings and insulation exposed to atmosphere only under dry site conditions and then for a cumulative period of not greater than eight hours.

During and after erection, precautions shall ensure that moisture and air are not trapped within the tank, pipe-work and coolers.

Transformers/reactors shall be supplied complete with the first filling of insulating oil, unless otherwise specified. For testing and commissioning, the oil shall be based and comply with the requirements of IEC 60296 High Grade Inhibited Oil,

Samples shall be taken from the transformer/reactor after the completion of site processing, and be shown to comply with the following requirements.

Requirements for Insulating Oil shall be in accordance with section 14.2 of this specification.

The oil in radiators, conservators, coolers and pipe-work shall be processed to remove any impurities, after filling, until it complies with the above requirements before being allowed to mix with the oil in the main tank.

After all compartments of transformers/reactors are filled with oil to their correct level and pressures equalised, the oil shall be circulated through the processing plant and circulation maintained for a minimum duration of eight hours, when the oil quality shall be checked for compliance with the above requirements. If necessary, the processing shall continue until these requirements are met. Transformers/reactors having forced oil cooling shall have their oil pumps running to circulate the oil through the tank and coolers during oil processing.

Note: The Purchaser will be responsible for ensuring that the necessary site supplies are available at the time of oil filling and processing.

The specified breathers must be fitted and made operational within forty-eight hours of the final oil filling and processing. Where this cannot be achieved due to site supplies not being available, a temporary silica-gel breather having a capacity equal to, or greater than, the specified breather, shall be fitted.

After erection, all blanking plates and special fittings shall be stored on site.

Damage to paint-work shall be made good.

The Contractor shall supply, erect and connect-up the apparatus provided under the Contract, including cabling to the approved terminal positions. He shall co-operate with the other contractors concerned in the completion and testing of this work, including the final checking and connecting-up of the small wiring, fitting of approved numbered ferrules and making the transformer/reactor ready for service.

Gap settings for protection devices for open terminal arrangements shall be set, at commissioning, as follows, unless otherwise stated by the Purchaser:-

HV windings of 132kV 710mm

HV windings of 33kV and below 315mm

The Contractor shall provide a Statement to the Purchaser, before commissioning, certifying that a site examination of all tap changer parts, after assembly to the associated transformer, has been made and that the tap changer is in correct working order.

APPENDIX 1

Western Power Distribution Appendix 1 Schedules

APPENDIX 5

Western Power Distribution standard commission checks

APPENDIX 6

CT DETAILS

SPC11-1 (30MVA)

SPC11-2 (45MVA)

SPC11-3 (60MVA)

SPC11-4 (90MVA)

SPC11-5 (30-30MVA)

APPENDIX 7

TYPICAL NOISE ENCLOSURE

G116393-0.0 Typical 132kV Transformer Enclosure Rev0.0 (A1).pdf

APPENDIX A

SUPERSEDED DOCUMENTATION

This document supersedes EE: SPEC 1/6 dated January 2017 which has now been withdrawn.

APPENDIX B

ASSOCIATED DOCUMENTATION

ENA Technical Specification 35-3 Issue 2 2014

A hyperlink to that document is provided below for use by WPD staff.

ENA_TS_35-3_Issue 2 (2014).pdf

It should be noted that this document is copyright and shall not be passed outside WPD. Copies can be purchased from Energy Networks Association.
Manufacturers tendering WPD would be expected to already hold a copy.

EE 142 Earthing and Auxiliary Transformers

APPENDIX C

IMPACT ON COMPANY POLICY

The following changes have been made in this version:-
Removal of unwanted sections and creation of separate Appendix 1 documents, WPD commissioning doc and earthing auxiliary transformer specification

APPENDIX D

KEY WORDS

Transformer, CER, CMR, Tapchanger.