Electricity Distribution

nationalgrid

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 4/8
Relating to 5 MVA (uprateable to 6.25 MVA) 33/11.5kV Transformers, Delta/Star and Star/Star connected.

Policy Summary

This specification covers Western Power Distribution's requirements for 5 MVA ONAN transformers uprateable to 6.25 MVA ONAF. It is based on BS EN 60076 with particular requirements based on ENA Technical Specification 35-2 Issue 6 – June 2014.

Author: Andrew Reynolds

Implementation Date: January 2020

Approved by

Carl Ketley-Lowe

Engineering Policy Manager

Date: 8th Jan 2020

Target Staff Group	**All Employees**
Impact of Change	**Green**
Planned Assurance checks	**Checks to be carried out that staff are ordering from the new framework agreement once awarded**

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 33/11.5kV 5/6.25MVA Primary 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 the use of inhibited insulating oil and Tier 2 losses

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**
January 2020	• Inclusion of tier 2 losses • Inclusion of inhibited oil • Minimum flow rate	Andrew Reynolds
May 2015	• Inclusion of revision table, update of drawing references and inclusion of new ECO Losses Directive 2009/125/EC	Andrew Reynolds

CONTENTS

FOREWORDS

All equipment supplied under this specification will meet the relevant technical requirements of BS EN 60076.

Additional clauses contained within this specification are in addition to the requirements of BS EN 60076. Where there is any conflict between BS EN 60076 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 design of accessories shall be co-ordinated so that the thermal rating of the transformer shall not be limited by these accessories.

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 that are not suitable for submersion shall be located above this level, with the exception of cooling fans, which, although preferably 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 that are below the 1m level that are not suitable for submersion shall be listed in Appendix 5 together with the reason for the non-compliance and the extent of damage and rectification needed following subsidence of the flood.

1.0 SCOPE

This specification covers the technical requirements for three-phase, oil immersed, 33/11.5kV and 33/11.5/6.9kV dual ratio, 50Hz, 5 MVA (up rateable to 6.25 MVA) transformers for use on systems having the 11.5kV neutral earthed directly or through resistance, reactance or arc suppression coil at one or more points.

Transformers offered by manufacturers are required to satisfy the eco-design regulations 2009/125/EC and to conform with the requirements associated 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 Teir 1 stated in the appropriate tables of Annex 1 of the eco-design regulations. Transformers supplied after July 2021 shall comply with Tier 2 losses of the regulation.

1.2 Service Conditions

1.2.1 The requirements of BS EN 60076-1, Clause 1.2.1 shall apply.

2.0 REFERENCES

Clause 2 of BSEN 60071-1 applies with the following additions**:-**

The Construction Design and Management Regulations 1994.
The Electricity Safety, Quality and Continuity Regulations 2002
The Electricity at Work Act 1989
The Health and Safety at Work Act 1974
Utilities Supply and Works Contract Regulations 1992
The Working at Height Regulations 2005
EN ISO 12944 -2:1998 Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments.
IEC 60076-1: 2000 Power transformers, Part 1: General
IEC 60076-2: 1993 Power transformers, Part 2: Temperature rise
IEC 60076-3: 2000 Power transformers, Part 3: Insulation levels, dielectric tests and clearances in air
IEC 60076-5: 2006 Power transformers, Part 5: Ability to withstand short-circuit
IEC 60076-7: 2005 Power transformers, Part 7: Loading guide for oil-immersed power transformers
IEC 60076-10: 2001 Power transformers, Part 10: Determination of sound level
IEC 60076-10-1: 2005 Power transformers, Part 10: Determination of sound level – Application guide
IEC 60137: 2003 Insulated bushings for alternating voltages above 1000V
IEC 60214-1: 2003 Tap-changers – Part 1: Performance requirements and test methods
IEC 60214-2: 2004 Tap-changers – Part 2: Application guide
IEC 60296: 2003 Unused mineral insulating oils for transformers and switchgear
IEC 60529: 1989 Specification for degrees of protection provided by enclosures (IP code)
IEC 60616: 1978 Terminal and tapping markings for power transformers
IEC 60694: 1996 Common specifications for high-voltage switchgear and control gear standards
ISO 9000: 2000 Management and Quality Assurance standards
BS 2562: 1979 Specification for cable boxes for transformers and reactors
BS 7354: 1990 Code of practice for design of high-voltage open-terminal stations
BS 6480: 1988 Specification for impregnated paper-insulated lead or lead alloy sheathed electric cables of rated voltages up to and including 33000 V
BS EN 50216-1: 2002 Power transformer and reactor fittings – General
BS EN 50216-2: 2002 Power transformer and reactor fittings – Gas and oil actuated relay for liquid immersed transformers and reactors with conservator
BS EN 50216-4: 2002 Power transformer and reactor fittings – Basic accessories (earthing terminal, drain and filling devices, thermometer pocket, wheel assembly)
EN 50216-5 prAA Draft specification for power transformer and reactor fittings Part 5:
Liquid level, pressure devices and flow indicators
BS EN 50216-6: 2002 Power transformer and reactor fittings –Cooling equipment – Removable radiators for oil-immersed transformers
BS EN 50216-7: 2002 Power transformer and reactor fittings – Electric pumps for transformer oil

BS EN ISO 780: 1999 Packaging. Pictorial marking for handling of goods
ENATS 12-11 Unfilled cable compartments for dry terminations in HV switchgear for service at rated nominal voltages 12, 24 and 36kV
ENATS 50-18 Design and application of auxiliary electrical equipment
ENATS 50-19 Standard numbering for small wiring (for switchgear and transformers together with their associated relay panels)
LPS 1175-5.1 Requirements and testing procedures for the LPCB approval and listing of burglary resistant building components, strong points and security enclosures
ASTM 1275-B Test method for corrosive sulphur in electrical insulating oils

3.0 DEFINITIONS

Transformers shall be suitable for installation outdoors and shall comply with the listed Standards except where modified in this specification.

4.0 RATING

The voltage ratio at no load on the principal tap shall be 33000/11500 volts or for dual ratio transformers 33000/11500/6900 volts.

The transformer shall have a continuous 5MVA ONAN rating at 20°C. The transformer shall have a cyclic overload rating under ONAN conditions of 7 MVA at 0°C and shall comply with BS EN 60076-7.

The transformer shall be designed for fitment of fans to achieve a continuous ONAF rating of 6.25 MVA at 20°C and a cyclic ONAF rating of 8.75 MVA at 0°C and shall comply with BS EN 60076-7. Fans should be fitted from new unless otherwise specified in Appendix 1 – Schedule of requirements.

The ratings of the transformer windings and all ancillaries shall be sufficient to meet the ONAF cyclic rating from the outset subject to a maximum peak load of 10MVA at 0ºC.

These ratings shall apply at any tap position, with a secondary terminal voltage of 11kV and the winding hot spot temperature not exceeding 140ºC and the oil temperature not exceeding 115ºC.

4.1 Loading Cycle

All transformers supplied under this specification shall meet the requirements of BS EN 60076 – 7.

5.0 REQUIREMENTS FOR TRANSFORMERS HAVING A TAPPED WINDING

5.1 The requirements of Clause 6.1 of BS EN 60076 – 1 shall apply

5.2 The requirements of Clause 6.2 of BS EN 60076 – 1 shall apply.

5.3 All tappings shall be full power tappings and no reduced power tappings shall be permitted.

5.4 The category of voltage variation shall be CFVV. The tapping range shall be ±8 x 1.25% (±10% in 16 steps). The numbering of the tap positions shall be such that an increase in tap number corresponds to an increase in voltage on the lower voltage side of the transformer. The taps shall be arranged as part of the HV winding.

5.5 The impedance shall be nominally 7% on 5 MVA BASE. For Star-Star units the zero phase sequence shall be stated in ohms/phase when tested in accordance with BS EN 60076.

5.6 For tender comparison purposes, either capitalisation figures or maximum guaranteed losses for each rating of transformer, as detailed in the Schedule of Requirements (Appendix 1) shall be used. Where maximum guaranteed losses are specified the guaranteed losses as declared in the Technical Schedule - Appendix 4 shall not exceed these values. The guaranteed losses shall be subject to the tolerances detailed in Clause 10 of BS EN 60076 – 1. The load loss shall be guaranteed at the ONAN rating.

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

6.0 CONNECTION AND PHASE DISPLACEMENT SYMBOLS FOR 3 PHASE TRANSFORMERS

Clause of BS EN 60076-1 applies. Options are given in Appendix 1.

Vector change links are not required.

7.0 RATING PLATES

Clause 8 of BS EN 60076-1 applies.

8.0 MISCELLANEOUS REQUIREMENTS

8.1 **Dimensioning of neutral connection**

The requirements of IEC 60076-1 Clause 8.1 shall apply. The purchaser shall state in the Schedule of Requirements (Appendix 1) whether or not the neutral conductor and terminal of the transformer are intended to carry load between phase and neutral.

8.2 **Oil preservation system**

The oil preservation system shall be free breathing with a maintenance free desiccant (silica gel) or refrigerating breather as determined by the manufacturer. Details of the system used shall be provided at time of tender for approval. Although the device is maintenance free it shall be positioned so that it is accessible from ground level for repair/maintenance.

8.3 Clause 9.3 of BS EN 60076-1 shall not apply.

8.4 All windings shall be of copper.

8.5 The maximum flux density in any part of the core or shields shall not exceed 1.65 tesla when the voltage applied to any tapping is that for which the tapping is designed.

8.6 The transformer, coolers, tapchanger and ancillaries shall be designed so that water collection points/traps are avoided.

8.7 The transformers shall be designed to withstand without damage external short circuits as specified in BS EN 60076-5, taking the 33kV short circuit apparent power of the system (clause 3.2.2.4) as 1000 MVA. The duration of the short circuit (clause 4.1.3) shall be 3 seconds.

9.0 TOLERANCES

Clause 10 of BS EN 60076-1 applies.

10.0 TESTS

Clause 11 of BS EN 60076-1 applies.

Options are given in Schedule of Requirements - Appendix 1.

10.1.1 **Routine Tests**

Parts a) to f) of Clause 11 of BS EN 60076-1 shall apply

Dielectric routine tests shall consist of:

Short duration ac test (ACSD) in accordance with Clause 12.2 of BS EN 60076-3
A separate source AC test in accordance with Clause 11 of BS EN 60076-3.

g) Determination of sound levels at ONAN, in accordance with BS EN 60076-10-1. The sound power levels derived from the measurements shall not exceed 63 dBA (ONAN) and 80 dBA (ONAF)

h) The cost of providing the FRA tests shall be included in the overall price, but identified separately at the time of tender. The FRA tests shall be carried out on the transformer before leaving the manufacturer's works and repeated again at site following assembly. The instrumentation, leads, etc. shall be arranged so that the conditions of test on site are as close as possible to the conditions of test at the manufacturer's works.

i) All tanks, conservators and oil filled compartments that are subjected, in service or during maintenance, to oil pressure shall, when filled with oil of a viscosity not greater than that of IEC 60296 at a temperature of 15ºC, withstand for a period of 24 hours without leakage a hydraulic test pressure equal to the normal pressure plus 0.35 bar. The pressure applied during this test must exceed the pressure required to operate the pressure relief devices by at least 100mbar.

Note: this test would normally be carried out by the use of an auxiliary oil header tank connected to the conservator that raises the head of oil in the transformer by approximately 4m. Pressure relief devices will need to be removed or blanked off for this test.

j) Measurement of positive sequence impedance at every tapping position.

k) Correct functioning of the tap-changer and driving mechanism.

On Star/Star transformers only, third harmonic voltage tests shall be made, in accordance with Clause 11.6 of BS EN 60076-1. Third harmonic voltage tests shall be carried out on star/star transformers with 33kV applied to the normal tap, with the LV winding open circuited. Readings of fundamental and third harmonic voltages shall be taken between phases of the HV winding and phase-to-phase and phase-to-neutral of the LV winding, due allowance being made for harmonics in the input voltage. The line-to-neutral output voltage wave shall not introduce more than 0.5% third harmonic component when the transformer is excited at 33kV on the normal tapping.

On Star/Star transformers only, measurement of zero phase sequence impedance in accordance with Clause 10.7 of BS EN 60076-1. On Star/Star transformers, measurements of zero sequence impedance shall be taken with 250A in the LV neutral and the HV winding open-circuited. The zero phase sequence impedance in ohms/phase shall lie within 11 to 19 Ω/Ø

10.1.2 **Type Tests**

a) A temperature rise at the ONAN rating in accordance with BS EN 60076-2.

b) A temperature rise at the ONAF rating in accordance with BS EN 60076-2.

c) Dielectric type tests consisting of Lightning impulse chopped on the tail (LIC) in accordance with Clauses 13 and 14 of BS EN 60076-3

d) Determination of sound levels at with all cooling in operation in accordance with BS EN 60076-10

10.1.3 **Special Tests**

The cost for a short circuit test in accordance with BS EN 60076-5 shall be provided at the time of tender, when a decision shall be made as to whether the test is required.

10.13 **Site Tests**

The following site tests shall be carried out by the manufacturer at the time of commissioning.

(i) The insulation resistance of each winding in turn to all other windings, core and frame or tank connected together and to earth shall be measured and recorded;

(ii) Insulation resistance measurement of all secondary circuits;

(iii) Check on calibration of winding temperature indicator(s) including heater current injection;

(iv) Test of gas-and-oil actuated relay operation;

(v) Operation of forced cooling equipment manually and from contacts on the winding temperature indicator(s) and check for mal-operation of gas-and-oil actuated relay;

(vi) Operation of tap-changer through the range and functioning of limit switches;

(vii) Check on voltage control equipment including automatic circuits by injected voltage and current;

(viii) Dielectric breakdown strength, moisture content and dissolved gas analysis on oil samples from main tank (top and bottom), tap-changer, cooler bank and auxiliary transformer (where fitted);

(ix) FRA test (if required)

(x) Core Earth Test

(xi) For all CT's

a) DC resistance
b) Flick test
c) Magnetisation Curves

11.0 ELECTROMAGNETIC COMPATIBILITY (EMC)

Clause 11 of BS EN 60076-1 applies.

12.0 TRANSFORMER DETAILS

Annex A of BS EN 60076-1 applies where this information is not already contained in this specification or in the schedule of requirements.

12.1 The transformer shall be three phase, designed to operate on a three phase system with a nominal frequency of 50Hz.

12.2 Unless otherwise agreed between the purchaser and the supplier, the transformer and all associated oil filled equipment shall be supplied complete with the first filling of unused inhibited, mineral oil complying with IEC 60296 transformer oil. The oil offered shall have the properties below.

Property	Test Method	Value
Dielectric Dissipation Factor at 90 ºC and 20 ºC	IEC 60247	Less than 0.0025
Flash Point (ºC)	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 needs to be identified at the time of tender and included on the rating plate and have a separate label at all filling points stating the oil name and do not fill with any oil other than the inhibited oil used.

12.3 Oil used shall be demonstrated to be free from any corrosive sulphur, likely to lead to the formation of copper sulphide. The oil shall pass an appropriate test for the detection of corrosive sulphur ("not corrosive" according to Cigre TF A2.32.01 unless another test is agreed by the purchaser.)

12.4 **Limiting Dimensions**

12.4.1 The overall height of the installation shall not exceed 4270mm

12.4.2 Anti-vibration mountings for the transformer, of a type and performance approved by the purchaser, shall be supplied. The percentage isolation value and details of the mountings shall be stated at the time of tender.

12.4.3 Flanges between radiator panels and the tank shall be equipped with valves.

12.5 **Auxilliary Supply Voltage**

The auxiliary supply voltage for the cooler and tap-changer shall be 230V (+10/-6%) single phase 50Hz.

13.0 CONSTRUCTION DETAILS

The manufacturer shall complete the details required in the table of 'Manufacturers and Places of Manufacture, Testing and Inspection', given in Appendix 2.

All external fixing bolts and studs will be stainless steel with an anti-galling paste applied, washers and nuts shall be of a different grade stainless steel to prevent any galling issues.

13.1 **Tanks and Covers**

The transformer tanks shall be complete with fittings detailed in Clause 13.6 of the specification and shall be designed so as to allow the transformer tank, complete with oil, to be moved by a crane, winch or jacks and transported by road, rail or water, without overstraining any joints and without causing subsequent leakage of oil. Tank bases shall facilitate handling with roller bars.

The design of transformers and associated plant should take into consideration the requirements of Health and Safety legislation with regard to working at heights. As far as is reasonably practicable, the transformer shall be arranged so that all routine test and maintenance work can be carried out from ground level. A socket for insertion of a work positioning restraining post (RidgeGear SSP Sub-Station fall arrest post) shall be provided as near the centre of the transformer lid as practicable. This shall be, generally, as detailed in the Figure 3.

Inspection openings shall be provided to afford access to and removal of internal current transformers, links and earthing connections. Each inspection opening cover shall be provided with lifting handles and its weight shall not exceed 25kg and shall comply with manual handling legislation. The weight of each inspection opening cover shall be clearly shown on the item to be lifted.

The design of tank covers shall be such that the formation of gas pockets and accumulation of moisture are avoided.

Where conventional bolted fixings for the tank cover are replaced by an approved welded construction, they shall be designed to permit the joint to be welded without damage to the gasket and prevent ingress of contaminant into the equipment. The flanges shall be of sufficient size to permit the welded joint to be made and removed at least four times. The routine oil pressure test as required by Clause 10.11(i) of this specification.

The centre of gravity shall be as low as reasonably practicable. The centre of gravity of the transformer shall be marked on at least two adjacent sides with symbol 7 of BS EN ISO 780. The centre-line of each side of the tank shall also be clearly marked.

13.1.1 **Gaskets**

Gaskets for weather and oil-tight joint faces should preferably be of synthetic rubber and cork composition having a minimum thickness of 5mm, except that where jointing faces are precision machined thinner gaskets may be used. Alternative gasket types may be proposed, which shall be subject to the approval of the Purchaser. Material specification and thickness of gaskets shall be provided in the Schedule of Conformance, Appendix 3.

Where dismantling requires gasketed joints to be broken after testing or other removal, new un-used gaskets shall be fitted. The re-use of gaskets in such re-assembly is not permitted.

13.2 **Surface Finish**

The transformer and its components (excluding insulating parts) shall not require maintenance for a period of at least 30 years in a polluted / coastal environment in accordance with Category C4 EN ISO 12944-2.

13.3 **Terminals**

13.3.1 **The HV connection shall be either**:-

(iv) Three outdoor bushings in accordance with IEC 60137 and Table 5. The bushings shall be mounted on turrets. Accommodation for two sets of protective current transformers to BS EN 60044-1, 15VA, class 5 P10 ratio 150/1 shall be provided.

TABLE 5
Outdoor Bushing Details

Voltage (kV)	Live Metal to Earth Flashover distance (mm)	Air end Creepage Distance (mm)	Stem Diameter (mm)	Stem Length (mm)
12 (Neutral)	250	406	16	60
36	500	1116	20 or 30	70 or 80

The supply of two sets of current transformers as specified above shall be included in the offer. The manufacturer shall supply a full specification including physical dimensions of all CTs installed.
Limiting dimensions for each current transformer are:

Inside Diameter - 75 mm minimum
Outside Diameter - 230 mm maximum
Length - 55 mm maximum

Protective current transformers provided shall be wired to terminal blocks in the control cubicle.

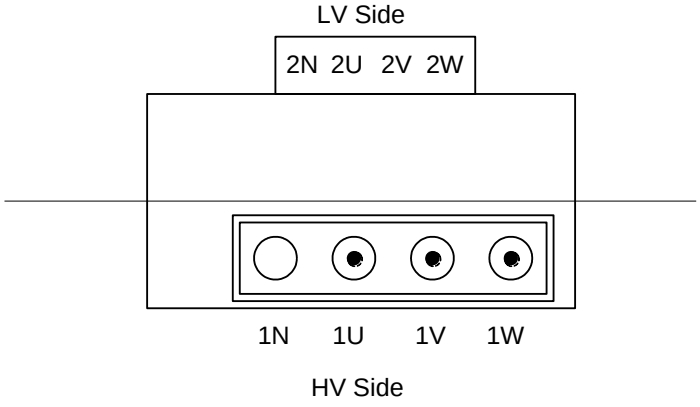
The HV bushings shall be fitted with a capacitor tap to allow Capacitance (pF) and Loss Tangent measurements to be taken to establish bushing condition.

Surge diverter brackets shall be provided. The bracket should have a 14mm diameter hole to accommodate a surge diverter with a single bolt fixing and suitable to accommodate a surge diverter with a length of up to 600mm when the busbar connection is horizontal.

The surge diverter brackets shall be fitted to accommodate busbars being connected from the HV side of the transformer, however it shall be possible to fit the surge diverter brackets on the opposite side of the bushing to accommodate the HV busbars being landed from the LV side across the top of the transformer.

Facility shall be available to fit a single arc gap of 305mm on each HV bushing, but as it is intended to use surge diverters these shall not be fitted.

The layout of the LV cable box and HV bushings shall be as shown below. The HV bushings shall not be on the same physical side of the transformer as the LV separable connectors.



Provision shall be made such that a transformer initially fitted with outdoor bushings can have these replaced by cable connection as detailed in 13.3.1 (v) below. It shall be possible to make these changes with minimum changes to the component parts.

or

(v) Three outer cone, bolted, interface C separable connector bushings to EN 50181, rated 36kV, 1250A continuous (Euromold type M400 AR-4 unless otherwise agreed in writing at time of tender) mounted on the vertical face of the tank wall to permit cable connection from below. A weather shield shall be provided over these bushings, having sufficient clearance to house one separable connector type M440 TB/G with dead end plug and cap, plus an additional 100 mm air clearance. The weather shield shall provide for access to unplug the separable connectors by removal of the front face of the weather shield and such bottom mounted parts as necessary. These removable components shall be fitted with handles as required and no single part shall weigh more than 25kg. Materials surrounding the single core cable entries shall be non ferrous to avoid eddy current heating effects and shall avoid a shorted turn being created by the tank wall. If the weather shield is unsuitable to carry the weight of a person weighing 150kg, suitable warning labels shall be applied to the front and top.

The phase markings shall be as detailed in Clause 13.3 with the HV and LV connections on the same side of the tank.

A supporting bracket shall be provided on the side of the transformer to support the 33kV cables and pre-drilled to mount Ellis Patent twin bolt fixing Atlas cable cleats type AR2-A13. Unless otherwise agreed, this bracket shall be mounted no more than 1 metre below the bushing. The bracket is likely to need bracing to either the tank wall or to the ground, it is preferred that the bracing be to the tank wall. The bracket shall be positioned such that when the Atlas cable cleats are fitted, the cables shall pass through the centre of the cleat and enter straight into the base of the connector housing. The Ellis Patent, Atlas cable cleats will not be supplied with the transformer.

An oil filled disconnecting chamber shall be provided to facilitate the disconnection of the transformer 33kV windings from the incoming cable. Each chamber shall be fitted with a drain valve and an air release valve. The oil in the chambers shall be separate from the oil in the main tank, being supplied through a separate pipe attached to the body of the chamber and fitted with an isolating valve from the transformer side of the main gas and oil actuated relay. Means shall be incorporated in the construction of the bushings to prevent rotation of the bushing stems when removing or replacing the links. A terminal shall be provided in each chamber to enable bushings not under test to be earthed. The links shall be of a design to prevent inadequate clearance, and with the links removed the clearances provided shall be adequate to permit site testing of the transformers and testing of the cables after installation in accordance with BS 6480.

The HV and LV cable boxes shall be positioned on the same side of the tank, the phase markings shall be 1U 1V 1W - 2W 2V 2U 2N from left to right when facing the boxes

Two sets of current transformers as detailed in 13.3.1 (iv) of this specification, mounted on suitable bushings to facilitate replacement, and easily accessible through a suitable access plate in the tank lid shall be provided.

Protective current transformers provided shall be wired to terminal blocks in the control cubicle.

Provision shall be made such that a transformer initially fitted with the above cable provision can have this replaced by outdoor bushings as detailed in 13.3.1 (iv) above. It shall be possible to make these changes without any changes to the component parts.

13.3.2 **HV Neutral**

The 33kV neutral point of each Star/Star connected transformer shall be supplied with an outdoor type bushing in accordance with Table 5 of this specification mounted vertically with the lowest point on the porcelain not less than 2580mm above ground level.

A bracket shall be provided near the base of the bushing to enable WPD to fit a surge diverter.

Facility shall be available to fit a single arc gap of 305mm, but as it is intended to use surge diverters this shall not be fitted.

13.3.3 **LV Terminations**

Four outer cone, bolted, interface C separable connector bushings to EN 50181, rated 36kV, 1250A continuous (Euromold type M400 AR-4 unless otherwise agreed in writing at time of tender) mounted on the vertical face of the tank wall to permit cable connection from below. A weather shield shall be provided over these bushings, having sufficient clearance to house two separable connectors type M440 TB/G with one connecting plug and a dead end plug and cap plus an additional 100 mm air clearance.

If specified in Appendix 1 - Schedule of Requirements, an oil filled disconnecting chamber shall be provided as detailed in Clause 13.3.1 (v) of this specification to disconnect the 11/6.6 kV windings from the outgoing cable.

A supporting bracket shall be provided on the side of the transformer to support the 11kV cables and pre-drilled to mount Ellis Patent twin bolt fixing Atlas cable cleats type AR2-A13. Unless otherwise agreed, this bracket shall be mounted no more than 1 metre below the bushing. The bracket is likely to need bracing to either the tank wall or to the ground, it is preferred that the bracing be to the tank wall. The bracket shall be positioned such that when the Atlas cable cleats are fitted, the cables shall pass through the centre of the cleat and enter straight into the base of the connector housing. The Ellis Patent, Atlas cable cleats will not be supplied with the transformer.

The weather shield shall provide for access to unplug the separable connectors by removal of the front face of the weather shield and such bottom mounted parts as necessary. These removable components shall be fitted with handles as required and no single part shall weigh more than 25kg. Materials surrounding the single core cable entries shall be non ferrous to avoid eddy current heating effects and shall avoid a shorted turn being created by the tank wall. If the weather shield is unsuitable to carry the weight of a person weighing 150kg, suitable warning labels shall be applied to the front and top.

It is a requirement to construct a bund wall around the transformer to contain an oil spillage. In constructing a bund it is necessary to fix ducts around all cables to above the height of the bund wall (up to 600 mm). It shall be possible to terminate and fit cables onto the bushings with this duct in place.

13.3.4 LV Neutral

A bracket, suitable for supporting a weatherproof outdoor neutral current transformer fitted around the neutral cable, is required vertically below the neutral cable connector.

13.3.5 Unit Auxiliary Transformer

When specified in Appendix 1, an auxiliary transformer shall be supplied. It shall be oil filled, 50kVA, 11,000 / 415V, 3 phase, 50Hz, 4.75% impedance, Dyn11 mounted on an additional flange to BS2562 facing 'E' with its major axis horizontal. Relevant dimensions are shown in Figure 1. The oil to the auxiliary transformer shall be supplied with a 25mm feed pipe from the transformer side of the main gas and oil actuated relay, fitted with a double flanged isolating valve and a gas-and-oil actuated relay to BS EN 50216-2. The auxiliary transformer shall be supplied via full range fuses that are situated in a chamber separate from the main transformer tank.

When no auxiliary transformer is specified the flange arrangement specified in Clause 13.3.5 shall be provided, but fitted with a blanking plate.

13.3.6 Core Earth Link

A core - earth link shall be provided either external to the tank or under oil at the top of the tank and accessible via a removable cover.

13.4 On-load Tap-changer

Each transformer shall be provided with a high speed, resistance transition, on load tapchanger of approved design and complying with IEC60214.

The tapchanger shall be of bolt on design. Where available the preference would be for vacuum bolt on technology that has passed a full type test as per IEC 60214-1

The tap-changer shall be capable of bi-directional power flow for its full rating.

13.4.1 Operating Mechanisms

Means shall be provided adjacent to the tapchanger motor for isolating the motor and the control gear from the supply, and a thermal device or other approved means shall be provided for the protection of the motor where necessary. The tapchanger mechanism shall incorporate a stored energy device that shall be fully charged before released, and once released shall control the speed and ensure complete travel of the tapchanger switch contacts.

The possibility of overrunning the mechanism at each end of the voltage range shall be prevented by means of limit switches and mechanical stops.

A mechanically operated indicator shall show the number of the tap position in use. The numbering of the tap position shall be such that an increase in number corresponds to an increase in voltage of the lower voltage side of the transformer.

When the tapchanger is switched to local operation, automatic or supervisory operation shall be inhibited.

13.4.2 Segregation of Compartments

A separate tapchanger conservator, fitted with an oil gauge and a self de-hydrating breather of approved design, shall be provided for oil in compartments of the tapchanger that contain contacts used for making and breaking current. An oil actuated relay that functions in the event of an oil surge shall be provided in the pipework to the conservator. The breather shall be positioned so that it is accessible from ground level for repair/maintenance.

13.4.3 Method of Operation

Each tapchanger shall be provided with local electrical and manual operation. Each tapchanger shall also be capable of remote operation from a modular voltage control scheme supplied under a separate contract.

13.4.4 Tapchanger Maintenance

Equipment shall be designed for minimum maintenance. Diagnostic testing and inspection shall be required at intervals of not less than six years. In any event, the switches and oil of the diverter switch and selector switch compartments shall be capable of withstanding 50,000 operations at maximum rated through current without requiring attention.

The manufacturer shall advise at time of Tender the maintenance requirements for the tapchanger offered, including current costs of parts and an estimate of man hours work.

The de-hydrating breather shall be accessible from ground level to facilitate maintenance.

Tapchanger control shall be to WPD schematic SPC11TCC2 South West and Midlands SPC11TCC1 South Wales

13.5 **Clearances to exposed conductors**

The following minimum safety clearances shall be provided in accordance with BS 7354:

(i) From fixed access points or ground level to live metal – 2900mm;
(ii) From nearest part, not at earth potential, of any insulator supporting a conductor to fixed access points or ground level – 2580mm. Unless adequately screened, this requirement shall also apply to the transformer side of insulators fitted to tank attached current transformers.

The minimum external air clearances shall be as shown in Table 7.

TABLE 7 - External Air Clearances

Highest Voltage for Equipment	**12kV mm**	**36kV mm**
Between live metal including neutral, and earth	500	500
Between live metal of different phases and phase to neutral	250	430
From live metal to any oil pipe work including conservator	500	500

13.6 **Fittings**

The following fittings shall be provided to BS EN 50216-1. The design of accessories shall be coordinated so that the thermal rating of the transformer shall not be limited by these accessories.

13.6.1 **Conservator**

Each transformer shall be provided with a conservator which shall have a minimum volume of 10% of the total transformer and cooler oil content, be mounted so as not to obstruct the electrical connections and incorporating the following:

(i) A removable end.

(ii) A sump formed by projecting the feed pipe a minimum of 75mm above the bottom inside surface of the conservator.

(iii) A filling orifice.

(iv) A 25mm drain valve arranged to drain the sump.

(v) An isolating valve arranged on the conservator side of the gas-and-oil actuated relay.

(vi) An oil level gauge with indicating levels corresponding to top oil temperature of minus 10°C, plus 15°C and plus 60°C and mounted so that it is readable by a person standing on the ground within 600mm of the tank or cooler.

The lowest indicated oil level shall be level with the top of the feed pipe and the minus 10°C mark not less than 25mm above the lowest indicated oil level. The highest indicated oil level shall correspond to the highest operating oil temperature at an ambient temperature of 40°C. There shall not be less than 50mm between the highest indicated oil level and the inlet to the breather pipe.

13.6.2 **Cooling Plant**

Fans shall not require separate foundation fixings. Radiators shall be to BS EN 50216 6.

Drain plugs shall be fitted for draining each section of the cooler.

Air release plugs shall be provided where necessary to facilitate oil fillings.

It is expected that pumps will not be used.

13.6.3 **Gas-and-oil actuated Relay**

For checking the operation and continuity of the electrical contacts each relay shall be provided with an internal injection nozzle associated with a test cock (to be operated standing at ground level and with facilities for locking in the closed position) to take a flexible pipe connection for air and oil injection.

Gas and oil actuated relays with magnetic reed contacts are not permitted.
Each transformer shall be provided with a gas-and-oil actuated relay to BS EN 50216 2.

Ground accessible petcocks for sampling shall be provided, with facilities for locking in the closed position. Relay test facilities shall be provided at ground level.

All gas and oil relays shall have a minimum flow rate of 1.2m/s

13.6.4 **Pressure Relief Device**

A spring-operated, self-resealing pressure relief device in accordance with EN 50216-5 draft amendment prAA shall be provided for the main tank. The flow of oil shall be directed downwards to within 1m of ground level by suitable ducting to avoid danger to personnel and to contain any oil spillage. The internal area of the ducting shall not restrict the operation of the pressure relief device or the flow of oil.

The device shall be flange mounted, preferably on the side of the tank. If it is not possible to mount the device on the side of the tank, and it is mounted on the cover, means shall be provided to prevent any gas collection in the chamber under the valve disc.

The outer end of the pipework shall be protected from ingress of vermin etc by a fine mesh grid, but the mesh shall not facilitate the formation of ice or paint spray to seal the outlet.

An approved, sealed, normally open, weatherproof trip switch shall be provided, cabled to the marshalling cubicle. Means shall be provided whereby the switch reset button or arm can be operated without removing the outer pipework.

13.6.5 **Winding Temperature Indicators**

Each transformer shall be provided with a winding temperature indicator or temperature sensor, and associated current transformer. Where a temperature sensor is specified, the required outputs shall be as detailed in the schedule of requirements.

The winding temperature indicator shall be of the electronic type for example Ashridge 852 plus, as specified in the Schedule of Requirements and shall meet the following requirements:

Means shall be provided, external to the winding temperature indicator case, for checking the operation and setting of the contacts, and 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 purchaser shall specify whether the switch shall have normally open, normally closed or change over contacts. The rated current shall be 2 A r.m.s. and the short time current 10 A r.m.s. for 30 ms. Other values may be agreed between purchaser and supplier.

The breaking capacity shall be:

24 V d.c. to 220 V d.c., 2 A, 250 W, L/R < 40 ms
230 V a.c., 2 A, 400 VA, cos j > 0,5

Other values may be agreed between purchaser and supplier.

The minimum contact life shall be 1000 operations. The switch shall also be able to make a low current down to 10 mA for any value of voltage as defined above, even after one year of non-operation.

Means shall be provided in the outdoor marshalling cubicle to allow for measuring oil temperature and testing the thermal gradient boost. It shall be possible to disconnect the CT so that the indicator functions as an oil temperature indicator. Means shall be provided to short the CT secondary, and it shall be possible to move from winding temperature function to oil temperature function without open circuiting the CT secondary (see example in Figure 2). The calibration of the indicator shall be related to the winding having the maximum temperature rise.

Where the values on the winding temperature indicator vary by more than plus or minus 3°C from the values derived during the temperature rise tests specified in Clause 10.1.2 of this specification, adjustment shall be made to the equipment to achieve these limits.

Where an electronic WTI is supplied the device shall be powered from a d.c. supply at a voltage rating as specified by the purchaser.

A second winding temperature indicator or temperature sensor, with its gradient boost operated from an independent current transformer and contacts arranged to duplicate the functions of the first instrument, shall be provided if specified in the schedule of requirements.

Facilities for remote indication for telecontrol purposes shall be provided. A Linear Variable Differential Transformer (LVDT) detecting movement of the pointer shall be provided. The output shall be 2mA to 10mA for the range 30ºC to 150ºC (equivalent to 1mA per 15ºC)

WTI capillary tubes shall be armoured PVC sheathed overall and of sufficient length to allow the cooler bank carrying the marshalling box to be sited at either end of the transformer.

The compensation of the WTI to read hot spot temperature shall be located within the WTI itself, rather than a heater around the temperature pocket on the top of the transformer.

The WTI shall be supplied with the following settings:-

Function	WTI Setting ºC
Fan "On"	80
Fan "Off"	70
Alarm	105
Trip	145

13.6.6 **Current Transformers**

The current transformer providing winding temperature indication shall be located at the discretion of the Manufacturer. Where a second winding temperature indicator is specified, the winding temperature indicator current transformers shall be arranged, one each in the LV and HV winding. Where a single winding temperature indicator is fitted, this shall preferably be arranged to replicate the “hottest” winding.

For voltage compounding purposes, a current transformer shall be provided within the transformer in the ‘b’ phase associated with the transformer LV winding. Where specified in the schedule of requirements, a second voltage-compounding current transformer shall be provided in phase ‘a’ for providing an alternative or further source of compounding injection in cases where a single-phase voltage transformer supplies the reference voltage. Compounding current transformer(s) shall be provided with short-circuiting and earthing facilities in the secondary terminal box on the transformer and shall be wired to the control cubicle where selection facilities shall be provided. The voltage compounding current transformer shall be rated at not less than 30VA Class 1.0.

All CT’s shall be provided with a 40 amp primary injection test loop. The test loops shall be terminated in a terminal box either mounted on the turret (if outdoor bushing are used), or on the tank side.

All CT’s must be positioned such that they can be readily replaced through an inspection plate with the transformer oil level still above the windings.

13.6.7 **Other Fittings**

The following fittings shall be provided on each transformer tank:

(i) A thermometer pocket to BS EN 50216-4 mounted in the top cover in the hottest oil, fitted with a weatherproof screw cap.

(ii) A 50mm combined drain and filter valve.

(iii) A 50mm filter valve at the top of the tank.

(iv) A 25mm double flanged drain valve for the tap-changer.

(v) An oil sampling device which shall be between 200 and 300mm above plinth height. Details of this device to be supplied at the time of tender.

(vi) Jacking plates, haulage eyes and lifting lugs.

(vii) A group of four 15mm holes with their axes horizontal, arranged on 50mm square centres for bolted fittings, shall be provided for earthing purposes on a suitable part of the main tank structure close to each of two bottom diagonal corners, one of which shall be below the LV neutral termination. Iidentical earthing tags shall also be provided on the main tank, as close as possible to, and below, each surge diverter mounting point (HV side only)

Facility shall be provided to support 50mm x 4mm copper earth tape horizontally between the 3 earth tags mentioned above and vertically from this horizontal run to ground level at a point on the tank as close to the central tag as possible. 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 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.

(xi) Isolating valves at each point of connection from the cooler to the main tank.

(xii) 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.

13.6.8 **Valves**

All valves shall close with a clockwise rotation, and the main inlet and outlet valves to separate cooler banks, where fitted, shall be provided with open and closed indicators visible from ground level.

Valves shall be capable of satisfactory and safe operation (without sticking or slamming) under all conditions of pressure, vacuum and oil flow.

All valves shall be capable of being padlocked in the closed or open positions. It shall be possible to meet all padlocking requirements by means of a padlock with 41mm square body and with a 4mm to 7mm diameter shackle having a clear inside width of 21mm and an inside length of 16mm to 45mm. The holes provided for the shackle shall not be less than 8mm diameter.

Filter valves shall be fitted with blanking plates.

13.7 **Marshalling and/or Control Box**

A marshalling box to terminate all cables from equipment mounted on the transformer, except for the tap changer, shall be provided. The box shall also contain the winding temperature indicators, test links and ammeter, where specified. The purchaser shall specify any other items that are to be included in the marshalling/control box.

The box shall meet the protection requirements of IP44 defined in IEC 60529, and shall be protected against condensation by adequate means. The door shall be provided with a suitable locking facility. The supply voltage for low temperature heaters shall be 230V (+10/-6%), 50 Hz. The box and equipment contained therein shall comply with ENA TS 50-18. The box may be mounted on the tank wall.

All marshalling boxes shall be mounted by suitable anti-vibration mountings.

The top of any marshalling / control box shall be less than 2.2m above ground level. Attention is drawn to the requirement given in Clause 2 of this specification for equipment being able to withstand flood water to 1m above plinth level.

Terminal boards shall preferably 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.

A RCD controlled 13A socket (MK Masterseal or equivalent) shall be fitted to the outside of the Marshalling/Control box.

Cooler Control circuitry shall be as WPD Drawing SPC201 for South West and the Midlands PSD 0890 for South Wales.

13.8 Interconnecting cables

All interconnecting cables between equipment mounted on the transformer and cooler and the marshalling box shall be double insulated and screened, stranded, with individual steel wires for armouring of suitable mechanical strength. The minimum conductor size shall be 1.5 mm2 (2.5 mm2 for current transformers and trip circuits). The interconnecting cables shall be supplied, installed and terminated by the transformer manufacturer.

Cores shall be numbered in accordance with ENA TS 50-19 and ENA TS 50-18.

14.0 DOCUMENTATION

All documentation shall be provided in English and the contents shall follow the general principles of IEC 60694, Clause 10, applied to transformers.

The manufacturer shall provide maintenance details of the transformer and tap-changer in the operational manual, and summary details of the proposed maintenance schedule shall be provided in the schedule of conformance.

14.1 Drawings

Drawings shall be to scale and fully detailed. Dimensions on drawings shall be in metric units. General arrangement drawings submitted shall be to a scale not less than 1:50 and all detail drawings not less than 1:20. Drawings shall be a minimum A4 ISO size, and shall not exceed in one direction 841mm. All drawings shall provide a clear margin 25mm wide along the bottom.

All drawings shall be submitted electronically in Autocad DWG format.

The manufacturer shall submit for comment, drawings clearly showing in full detail, the equipment. The following drawings, where applicable, are to be provided for comment:

(i) Dimensioned outline arrangement of transformers and coolers.

(ii) General arrangement of outdoor marshalling/control box.

(iii) Wiring details of complete equipment.

(iv) Multicore cable schedule.

(v) HV termination details.

(vi) HV disconnecting chamber, where supplied.

(vii) HV bushing arrangement.

(viii) LV termination details.

(ix) Rating and diagram plate.

Generic drawings shall be supplied preferably within 2 months and no longer than 3 months of receipt of order.

All drawings shall be approved by WPD before manufacture commences

After construction and commissioning the manufacturer shall incorporate any alterations in these drawings, which have occurred during site work and these shall be completed within 2 months of the completion of site works.

14.2 Assembly, Operating and Maintenance Instructions

The manufacturer shall submit an electronic copy of the Assembly, Operating and Maintenance Instructions and Diagrams for comment by the Purchaser, in a format to be agreed between Purchaser and Manufacturer. After comment, the Manufacturer shall supply one hard copy in durable form to be shipped with the transformer, and one electronic copy. The instruction manual shall contain all relevant factory test data and, where the unit is not type tested, type test data from an equivalent unit shall be included.

15.0 PROGRAMME AND PROGRESS INFORMATION

The manufacturer shall provide within one month of the date of WPD's order a detailed manufacturing programme for each transformer. These copies shall be sent to the WPD nominated Engineer. The programme shall include delivery date to site, erection, commissioning test and handover dates. This programme shall then be updated on the first working day of each month following to the Engineer named. In the event of changes to the programme, detail should be provided on the reason for the change.

16.0 DELIVERY AND ERECTION

16.1 The manufacturer shall deliver the transformer to site, off load, carry out all site erection onto prepared foundations, and undertake all site tests specified in Clause 10.13 of this specification. Site erection staff shall be proficient in English. Two copies of all site test results shall be provided to WPD prior to handover.

16.2 All the above work will be carried out in co-operation with the WPD’s staff.

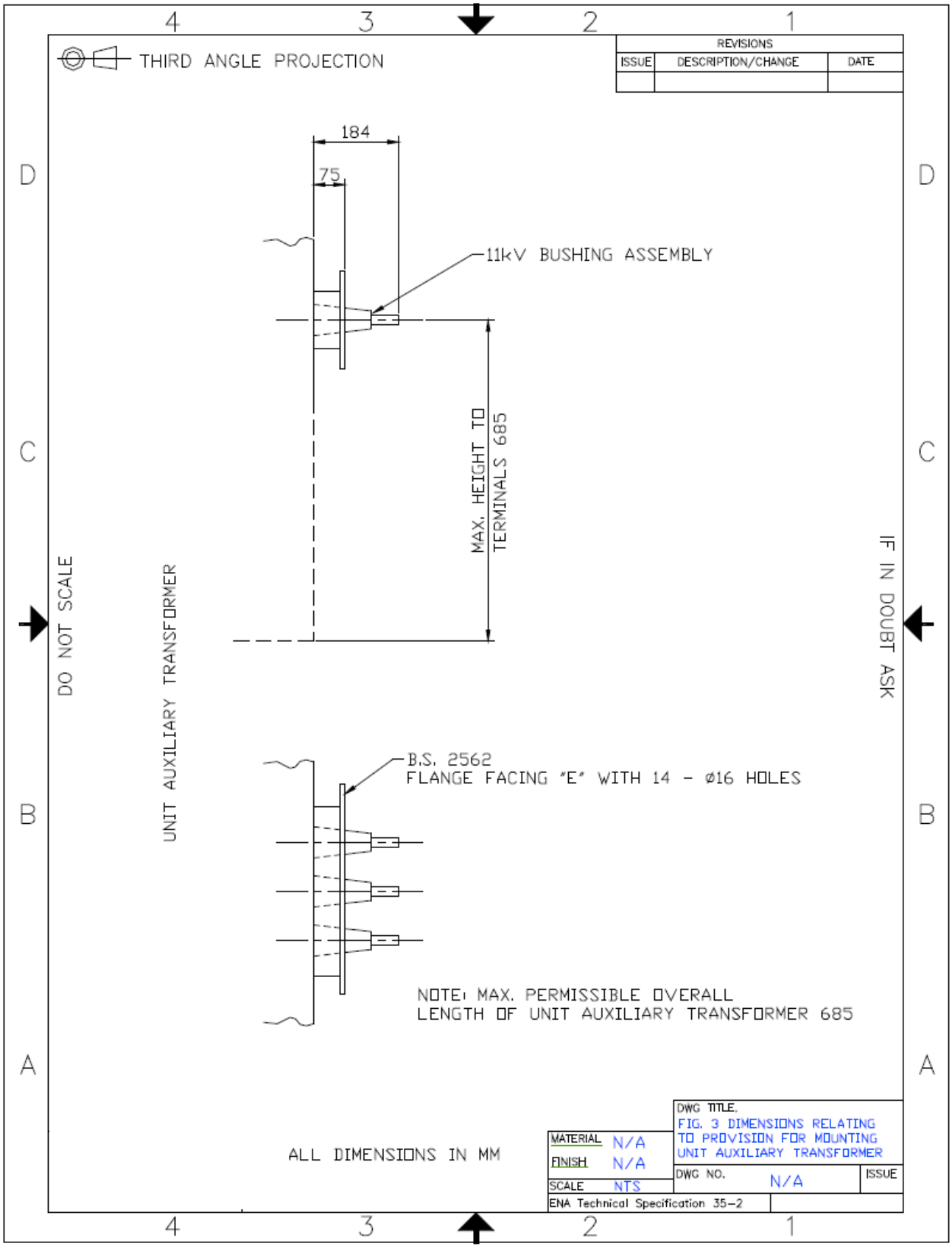


Figure 1. Dimensions Relating to Provision for Mounting Unit Auxiliary Transformer

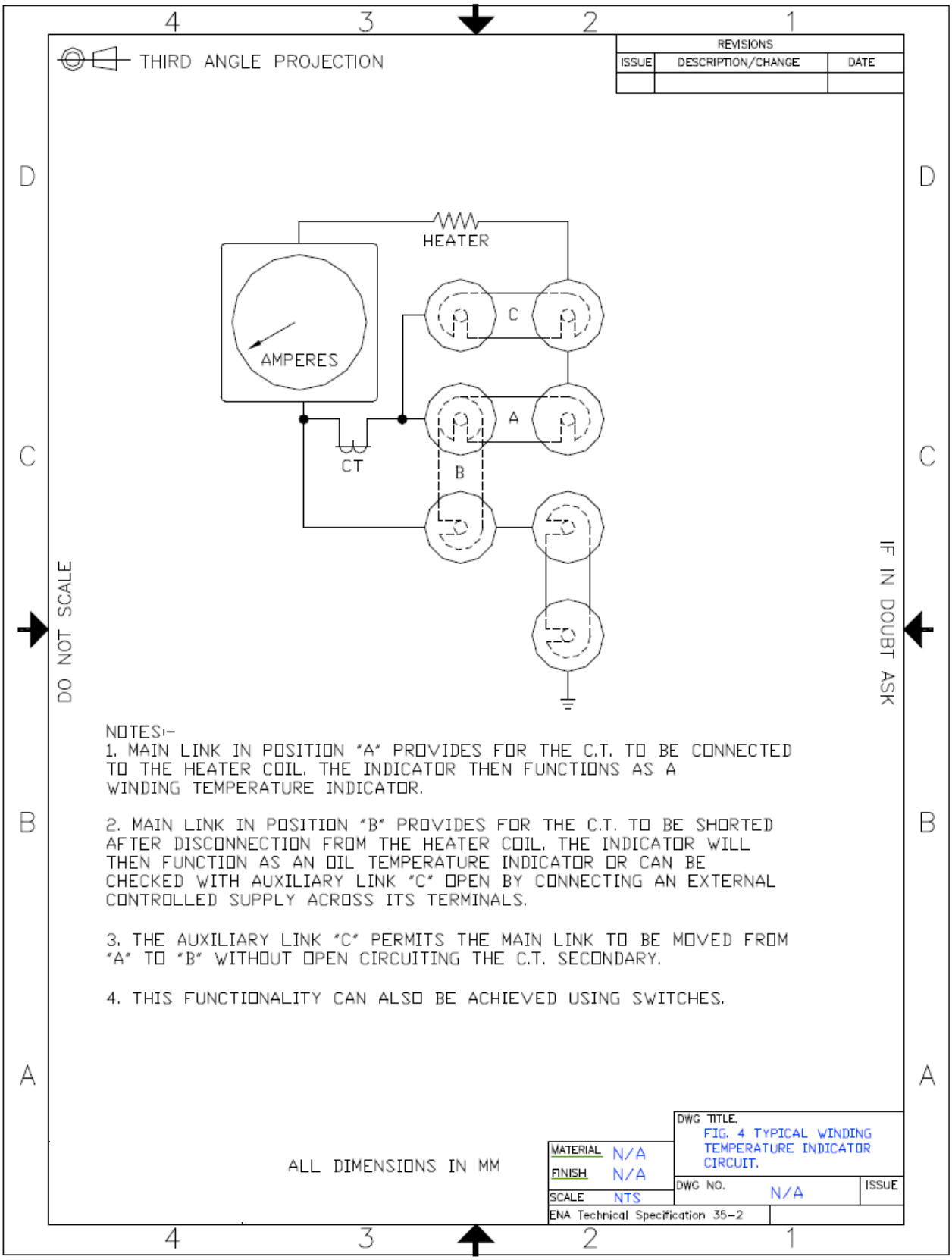


Figure 2. Typical Winding Temperature Indicator Circuit

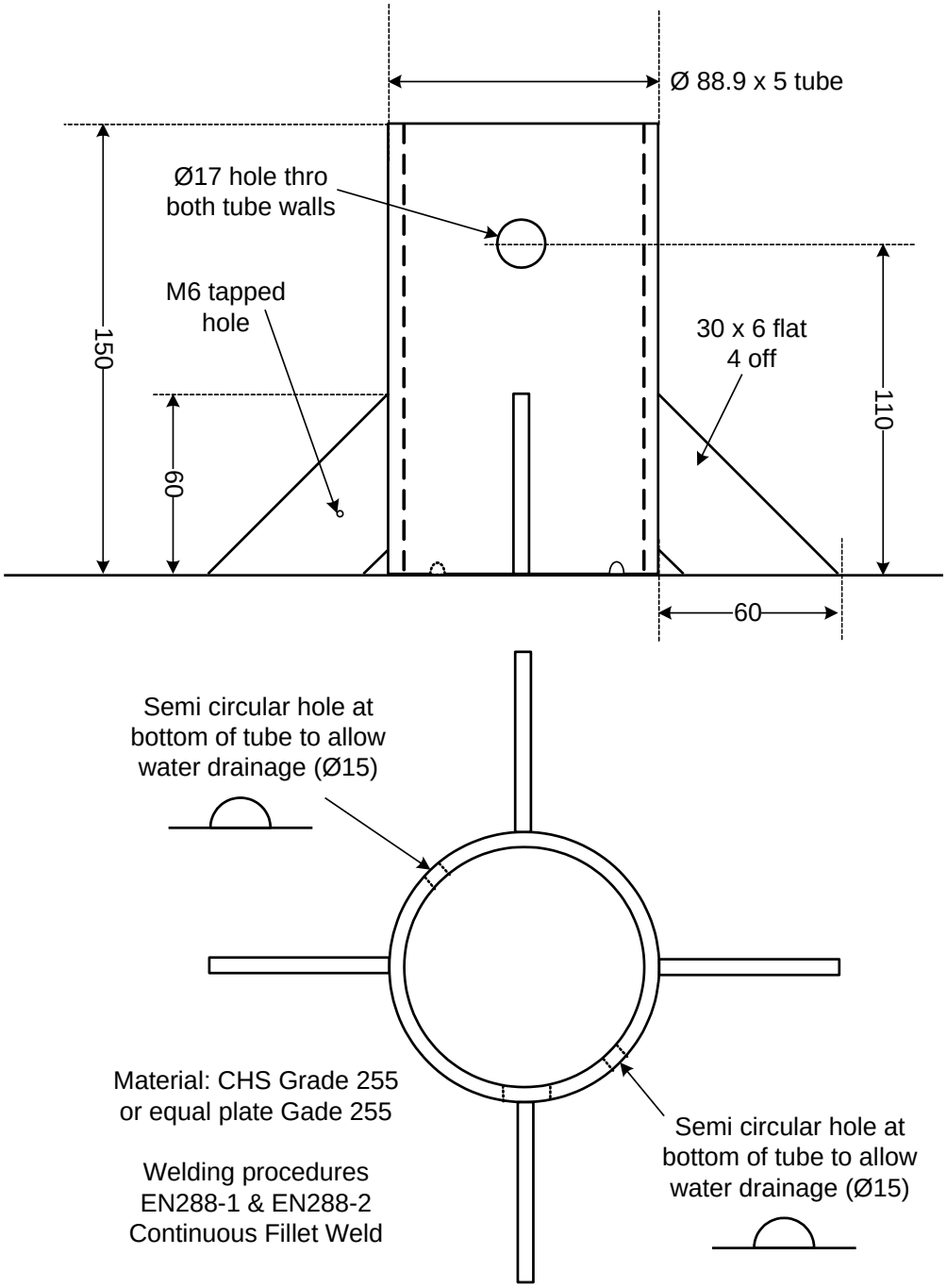


Figure 3 – Socket for work positioning restraining post

APPENDIX 1

SCHEDULE OF REQUIREMENTS FOR EMERGENCY RATED SYSTEM TRANSFORMERS: 33/11.5KV

(To be completed by Purchaser) * Purchaser to delete as appropriate

Item	Clause	Description	
1	3.0	HV Nominal Voltage kV LV Nominal Voltage kV	33 33 or 11.5 11.5/6.9
2	4.0	Fans to be fitted	Yes / ~~No~~
3	5.6	Loss Capitalization Values (i) No-load Loss £/kW (ii) Load Loss at 50% CER rating £/kW OR Maximum Guaranteed Losses in accordance with 5.6 (i) No-load Loss W (ii) Load Loss at 50% CER rating W	
4	6	Vector group (add phase displacement number)	* Dyn11 / YNyn0
5	6	Vector Links required If yes, alternative vector group	* ~~Yes /~~ No
6	8.1	Neutral conductor and terminal intended to carry load	*~~Yes /~~ No
7	8.2	Oil preservation system If free breathing, breather type	* Free breathing~~/ Diaphragm conservator~~ * Maintenance free self-dehydrating breather
8	8.3	Generator transformer load rejection per 8.3	* ~~Yes /~~ No
9	10.1.1	FRA test required at works and on site	* Yes /~~ No~~ Cost to be advised at time of tender
10	10.1.3	Short circuit test required	* ~~Yes / No~~ Cost to be advised at time of tender
11	12.4.2	Anti-vibration mountings required (Main TX)	* Yes ~~/ No~~
12	12.5	Auxiliary supply voltage	*~~400 V 3 ph /~~ 230 V 1ph
13	13.2	Finish colour required	Dark Admiralty Grey unless otherwise approved
14	13.3	Position of cable boxes	* Same side of tank ~~/ Manufacturer to decide~~

Item	Clause	Description	
15	13.3.1	HV terminal arrangement	* ~~(i) / (ii) / (iii) /~~ (iv) / (v)
		NVD capacitor taps required	*~~ Yes /~~ No
		NVD capacitance if required pF	* 60 / 90 / 140
		Surge arresters required	* ~~Yes /~~ No
		Brackets for surge arresters required	* Yes~~ / No~~
16	13.3.2	HVN terminal arrangement	* ~~(i)~~ / (ii) / ~~(iii) / (iv)~~
17	13.3.3	LV Terminal arrangement	* ~~Cable box /~~ separable connectors – see Clause 13.3.3 for details
		Number and size of single core cables to be terminated	Clause 13.3.3 for details
		LV cable link disconnecting chamber required	*Yes / No
18	13.3.4	LVN terminal arrangement	~~* (i) /~~ (ii) ~~/ (iii) / (iv)~~
		Number and size of single core cable to be terminated	
		LVN current transformer(s) required	* ~~Yes /~~ No – Mounting bracket only required
		Details of LVN current transformer(s)	
19	13.3.5	Auxiliary Transformer required	* Yes / No
20	13.4.1	Max / min tap position indicator required	* ~~Yes /~~ No
21	13.6.5	Winding temperature indicator or sensor	* Indicator ~~/ Sensor~~
		Output required from sensor	
		Winding temperature indicator type	* Electronic
		Second WTI or sensor required	*~~ Yes /~~ No
		Electronic WTI d.c. supply voltage Minimum (V)	
		Maximum (V)	
22	13.6.6	Second voltage compounding CT required	* ~~Yes /~~ No, but space for a second one shall be provided.

APPENDIX 2

MANUFACTURERS AND PLACES OF MANUFACTURE, TESTING AND INSPECTION

(To be completed by Tenderer)

MANUFACTURERS AND PLACES OF MANUFACTURE, TESTING AND INSPECTION *(To be completed by Tenderer)* **Item**	**Manufacturer's Drawing Number and/or Type Designation**	**Manufacturer**	**Place of Manufacture**	**Place of Testing and/or Inspection**
Transformers Complete On-load Tap-change Equipment HV Bushings LV Bushings Neutral Bushings Radiators Pipework Expansion Devices Oil Valves Oil Pumps Oil Pump Motors Fans Fan Motors Dehydrating Breather Gas and Oil Actuated Relay(s) Outdoor Marshalling or Composite Cubicle Indoor Control Cubicle Temperature Indicating Devices Auxiliary Transformer Material for Anti-vibration Mounting Noise Enclosure Test Equipment / Company used for FRA tests				
Any deviation from this Schedule shall be notified in writing as soon as possible for the Purchaser's approval				

APPENDIX 3

SELF-CERTIFICATION CONFORMANCE DECLARATION FOR 5/6.25MVA TRANSFORMERS: 33/11.5KV

CLAUSE BY CLAUSE CONFORMANCE WITH THIS SPECIFICATION

Transformers covered by this specification shall comply with the latest issues of the relevant International and British Standards. This specification is intended to amplify and/or clarify the requirements of those standards.

This check sheet identifies the clauses in this specification and the clauses of IEC 60076-1. The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.

Conformance declaration codes	Instructions for completion
N/A = Clause is not applicable / appropriate to the product Cs1 = The product conforms fully with the requirements of this clause Cs2 = The product conforms partially with the requirements of this clause Cs3 = The product does not conform to the requirements of this clause	• When Cs2 or Cs3 is entered, the reason for non-conformance shall be entered • Where options are specified, the remark should identify the option offered by the manufacturer • The manufacturer should complete the schedule items in the Remarks column. Additional sheets may be referred to where more detail is required.

Clause / Sub-clause	**Requirement**	**Conformance Code IEC 60076-1**	**Conformance Code - This Specification**	**Schedule item**	**Remarks**
Forewords	Flood Resiliance				
1 1.1	Scope and service conditions Scope			N/A	
1.2	Normal Service Conditions		N/A	N/A	
2	Normative references			N/A	
3	Definitions		N/A	N/A	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code - This Specification	Schedule item	Remarks
4 4.1	Rating Rating				
4.2	Loading cycle				
5 5.1	Tapped windings Notation of tapping range		N/A	N/A	
5.2	Tapping voltage, current, etc		N/A	N/A	
5.3	Tapping power		N/A	N/A	
5.4	Specification of tappings			Tapping range offered	
5.5	Specification of short-circuit impedance			Graph of impedance vs. tap position	
6	Connection and phase displacement symbol			Vector group Alternative vector group where links are provided	
7 7.1	Rating plates Information to be given in all cases		N/A	N/A	
7.2	Additional information to be given		N/A	N/A	
8 8.1	Miscellaneous requirements Dimensioning of neutral connection			Is neutral connection dimensioned for load current?	
8.2	Oil preservation system			Description of oil preservation system	
8.3	Load rejection on generator transformers			Is the transformer suitable for generator transformer load rejection?	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code - This Specification	Schedule item	Remarks
8.7	Withstand of external short circuit				
9	Tolerances		N/A	N/A	
10 10.1	Tests General requirements			N/A	
10.1.1	Routine tests			Guaranteed sound power level at ONAN dB(A)	
10.1.2	Type tests			Are type test results from an identical unit available? Guaranteed sound power level at CER dB(A)	
10.1.3	Special tests			Guaranteed and expected change of impedance after short-circuit test Special tests included in offer	
10.2	Measurement of winding resistance		N/A	N/A	
10.3	Measurement of winding ratio and phase displacement		N/A	N/A	
10.4	Measurement of short-circuit impedance and load-loss			N/A	
10.5	Measurement of no-load loss and current		N/A	Guaranteed no-load loss kW	
10.6	Measurement of harmonics		N/A	N/A	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code - This Specification	Schedule item	Remarks
10.7	Measurement of ZPSI			Guaranteed ZPSI Ω/ph	
10.8	Tests on OLTC		N/A	N/A	
10.9	Temperature Rise at Emergency Rating	N/A		N/A	
10.10	Determination of Sound Levels	N/A		N/A	
10.11	Pressure test	N/A		N/A	
10.12	Frequency Response Analysis	N/A		Is frequency response analysis is included in offer?	
10.13	Site tests	N/A		N/A	
11	EMC		N/A	N/A	
12 12.1	Transformer details No. of phases and frequency	N/A		N/A	
12.2	Cooling medium	N/A		Cooling medium offered	
12.3	Cooling	N/A		Cooling type	
12.4 12.4.1	Limiting dimensions	N/A		Does the transformer meet requirements of 12.4.1?	
12.4.2	Anti-vibration mountings	N/A		Percentage isolation value and description of AV mountings	
12.5	Auxiliary supply voltage	N/A		Supply voltage for tap-changer and cooler	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code - This Specification	Schedule item	Remarks
13 13.1	Construction details Tanks and covers	N/A		Is offer for bolted or welded cover?	
13.1.1	Gaskets	N/A		Description of gasket material and thickness	
13.2	Surface finish	N/A		Finish colour offered	
13.3	Terminals	N/A		Are separate disconnecting chambers provided? Position of HV and LV terminals	
13.3.1	HV terminals	N/A		Type of terminals offered	
13.3.2	HV neutral terminal	N/A		Type of terminal offered	
13.3.3	LV termination	N/A		Type of termination offered	
13.3.4	LV neutral termination	N/A		Type of termination offered	
13.3.5	Unit auxiliary transformer (UAT)	N/A		Is flange and valve for UAT included?	
13.4	On-load tap-changer	N/A		N/A	
13.4.1	Operating mechanism	N/A		Description of motor protection Is a max/min tap position indicator included?	
13.4.2	Segregation of compartments	N/A		N/A	
13.4.3	Method of operation	N/A		N/A	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code - This Specification	Schedule item	Remarks
13.5	Clearance to exposed conductors	N/A		N/A	
13.6	Fittings	N/A		N/A	
13.6.1	Conservator	N/A		N/A	
13.6.3	Gas-and-oil actuated relay	N/A		N/A	
13.6.4	Pressure relief device	N/A		N/A	
13.6.5	Winding temperature indicators	N/A		Description of provision of winding temperature indication Is a second WTI included?	
13.6.6	Current transformers	N/A		N/A	
13.6.7	Other fittings	N/A		N/A	
13.6.8	Valves	N/A		N/A	
13.7	Marshalling/control box	N/A		Means of condensation protection Description of security	
13.8	Interconnecting cables	N/A		N/A	
14	Documentation	N/A		Proposed maintenance schedule	
14.1	Drawings	N/A		Electronic drawing format	
14.2	Assembly, operation and maintenance instructions			Electronic format for instruction manual	

APPENDIX 4

TECHNICAL SCHEDULE

(To be completed by Tenderer)

Item	Description			5/6.25 Star Star	5/6.25 Delta Star	5/6.25 Delta Star Dual Ratio
	MAGNETIC CIRCUIT					
1.	Core					
	(a)	Maximum flux density (Tesla)				
		Construction of core				
	(b)	Taped/banded/bolted limbs				
	(c)	Taped/banded/bolted yokes				
	(d)	Taping/banding material (as applicable)				
2.	Insulation of:					
	(a)	Core bolts				
	(b)	Core bolt washers				
	(c)	Side plates				
	(d)	Core laminations				
	WINDINGS					
3.	Types and arrangements of:					
	(a)	HV windings				
	(b)	LV windings				
	(c)	Tapping windings (as applicable)				
	(d)	Winding arrangement ie Core/...../...../...../.....				
4.	Conductor Insulation:					
	(a)	HV windings				
	(b)	LV windings				
	(c)	Tapping windings (as applicable)				
5.	Oil circulation (eg neutral/partially directed/directed):					
	(a)	To windings -				
		(i)	HV windings			
		(ii)	LV windings			
		(iii)	Tapping windings (as applicable)			
	(b)	Through windings -				
		(i)	HV windings			
		(ii)	LV windings			
		(iii)	Tapping windings (as applicable)			
6.	Short circuit capability:					
	(a)	Potential axial thrust for worst fault condition of each winding-				
		(i)	HV windings, tonnes			
		(ii)	LV windings, tonnes			
		(iii)	Tapping windings (as applicable) tonnes			

Item	Description				5/6.25 Star Star	5/6.25 Delta Star	5/6.25 Delta Star Dual Ratio
6.	Short circuit capability (Cont'd):						
	(b)	Coil clamping short circuit withstand capacity -					
		(i)	HV windings	tonnes			
		(ii)	LV windings	tonnes			
		(iii)	Tapping windings (as applicable)	tonnes			
7.	Current density in windings (at normal tapping position):						
	(a)	HV windings (ONAF Cyclic)		A/mm²			
	(b)	LV windings (ONAF Cyclic)		A/mm²			
	(c)	Tapping windings (as applicable) (ONAF Cyclic)		A/mm²			
	PERFORMANCE CHARACTERISTICS						
8.	Rated power ONAF at 20ºC ambient and hot spot temperature of 98ºC			MVA			
9.	Hotspot temperature ONAN at 20ºC ambient			ºC			
10.	No load loss at normal tap (excluding cooling plant loss)			kW			
11.	Cooling plant loss			kW			
12.	Load losses:						
	(a)	ONAN rating, 75ºC, normal tapping		kW			
	(b)	ONAF, extreme negative tapping		kW			
13.	Transformer Sound Power Level dBA Cooler Sound Power Level dBA						
14.	TANK AND COOLER THICKNESS						
	(a)	Tank Sides		mm			
	(b)	Tank Base		mm			
	(c)	Tank Cover		mm			
	(d)	Radiator plates					
15.	Total oil required (including cooling system)			litres			

Item	Description		5/6.25 Star Star	5/6.25 Delta Star	5/6.25 Delta Star Dual Ratio
16.	Volume of oil to be removed:				
	(a) To gain access to core earthing link	litres			
	(b) To effect in-situ change of hv bushing	litres			
17.	Total volume of conservator(s)	litres			
18.	Volume of oil in conservator between highest and lowest visible levels	litres			
19.	Continuous rating of oil pump motor	shaft kW			
20.	Starting current of oil pump motor	amp			
21.	Total number of fans				
22.	Nominal diameter of fans	mm			
23.	Speed of fans	rev/min			
24.	Continuous rating of each fan motor	shaft kW			
25.	Starting current of each fan motor	amp			
	GENERAL				
26.	Filling medium for transport				
27.	Total weight as installed in service, including cooler plant, all fittings and oil	tonnes			
28.	Weight of cooler, complete with oil, conservator etc.	tonnes			
	TAPCHANGER				
29.	Maintenance requirements - (eg years/operations) describe:				
30.	Vol of oil to be removed for tapchanger maintenance	litres			
31.	Cost of parts required for tapchanger maintenance - Itemised list.	£			
32.	PAINT SYSTEM				
	Provide detail of paint system including details of 'on-site' repair system				

APPENDIX 5

Clause 2.0 calls for the transformer and its ancillaries to be designed such that it can continue in operation in times of flood when water levels reach 1m above plinth level. Any exceptions to this shall be listed below:-

Item on Transformer not suitable for submersion and below the 1m level	**Reason for non-compliance**	**Height of flood to which Item will survive**	**Likely damage and repair necessary after the flood has subsided**

APPENDIX A

SUPERSEDED DOCUMENTATION

This document supersedes EE SPEC: 4/7 dated May 2015 which has now been withdrawn.

APPENDIX B

RECORD OF COMMENT DURING CONSULTATION

No Comments received

APPENDIX C

ASSOCIATED DOCUMENTATION

None

APPENDIX D

IMPACT ON COMPANY POLICY

Inclusion of tier 2 losses
Inclusion of inhibited oil
Minimum flow rate for gas and oil relay

APPENDIX E

KEY WORDS

Transformer, CER, CMR, Tapchanger.