WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 5/5

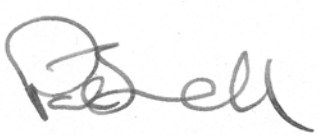
Relating to 11kV Distribution Transformers

Policy Summary
This specification covers the requirements for Distribution Transformers from 16kVA single phase to 1000kVA three phase for use on Western Power Distribution's system. It is based on ENA Technical Specification 35-1 Issue 5 - June 2007.

Author: **Andrew Reynolds**

Implementation Date: **August 2014**

Approved by



Policy Manager

Date: 3 September 2014

IMPLEMENTATION PLAN

Introduction
This document defines the 11/.433 Distribution 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 latest Eco Directive for transformer losses.

Impact of Changes
From 1st July 2015 we will be required to purchase and install transformer meeting the new specification, the decision has been made to introduce a new contract before this cut off date to make sure that all stock is to the new specification this date is anticipated to be 1st April 2015.

Implementation Actions
Procurement will tender a revised transformer contract.

Implementation Timetable
Once the contract has been revised and awarded, teams will see the new specification units being delivered to them. This is expected to be April 2015 onwards.

Document Revision & Review Table		
Date	**Comments**	**Author**
Aug 2014	• Change of losses to new Eco losses in accordance with General formatting changes	Andrew Reynolds
Date	**Comments**	**Author**
July 2013	• Update to include Surge Arresters • Included references for the Midlands • Inclusion of padmounts	Andrew Reynolds
Date	**Comments**	**Author**
July 2013	• Inclusion of Revision table	Andrew Reynolds

1.0 SCOPE

This specification covers the technical requirements for single-phase and three-phase, 50Hz, oil immersed, naturally cooled, transformers in the range 16kVA to 1000kVA for continuous service suitable in all respects for indoor or outdoor service.

Sections 1 to 14 are applicable to all types of Distribution Transformers.
Section 15 covers specific details applicable to Cable Connected Transformers.
Sections 16 and 17 cover specific details applicable to Unit Type Transformers.
Section 18 covers specific details applicable to Pole mount Transformers.
Section 19 covers specific details applicable to Padmount Transformers.

2.0 FOREWORDS

All equipment supplied under this specification will meet the relevant technical requirements of

ENA Technical Specification 35-1, Issue 5, June 2007 - Distribution Transformers (from 16kVA to 2000kVA).

Additional clauses contained within this specification are in addition to the requirements of the standards outlined in ENA Technical Specification 35-1. Where there is any conflict between ENA Technical Specification 35-1 and this document, then this specification shall take precedence.

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.

Clause numbers in this specification correspond to clause numbers in ENA Technical Specification 35-1.

Three phase transformers shall be connected Delta-Star, in accordance with vector group reference Dyn11 of IEC 60076.

All three phase transformer losses are now in accordance with European Eco Directive 2009/125/EC. Single phase transformer remain unaffected by the Eco Directive

3.0 DEFINITIONS

Clause 3 of ENA Technical Specification 35-1 applies.

4.0 RATING

Clause 4 of ENA Technical Specification 35-1 applies.

5.0 REQUIREMENTS FOR TRANSFORMERS HAVING A TAPPED WINDING

Clause 5 of ENA Technical Specification 35-1 applies.

Clause 5.4.1 – On single-phase pole-mounted transformers rated 50kVA and under, with standard voltage ratios, tappings shall be provided on the lower voltage winding for a variation of the no load primary voltage of -5%, 0 and +5% by means of connection to external LV bushings. As an alternative a tapping switch can be provided.

Clause 5.4.2 - On all other transformers tappings shall be provided on the higher voltage winding for a variation of the no-load primary voltage of -5 %, -2½ %, 0, +2½ % and +5 % (CFVV). The tappings on dual ratio transformers shall afford the specified variation for 11 000 V operation, for 6 600 V operation the variation shall be -8.4 %, -4.2 %, 0, +4.2 % and +8.4 %.

On single-phase transformers, the tappings shall be provided by means of a tapping switch meeting the requirements below. - Internal captive connectors are not permitted.

Clause 5.4.2 - On three-phase transformers, the tappings shall be provided by means of an externally operated self-positioning tapping switch in accordance with IEC 60214-1 Section 7 – Requirements for Off-Circuit Tap-Changers. Switch position no. 1 shall correspond to the maximum plus tapping. Provision shall be made for locking the tapping switch handle at any tapping position, 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. The switch shall be retained in a safe position if a padlock with a 4 mm diameter shackle is used. Padlocks shall not be provided. A label in accordance with **figure 15 shall be fitted adjacent to the tapping switch see Appendix C.**

Clause 5.6 - Capitalisation figures shall be used for tender comparison purposes. However, in any event, the transformer losses shall meet, or be lower than, those specified below and shall be in accordance with 2009/125/EC.

Single Phase pole mounted transformer losses

Single phase rating - kVA	16	25	50	100
No Load Loss	48	65	113	243
Load Loss	405	559	973	1636

Three phase pole mounted transformer losses

Three phase rating -kVA	25	50	100	200	315
No Load Loss	70	90	145	356	520
Load Loss	636	1100	1750	2750	3900

Three phase ground mounted transformer losses

Three phase rating -kVA	315	500	800	1000
No Load Loss	360	510	650	770
Load Loss	3900	5500	8400	10500

Clause 5.6 - In addition to the requirements of Clause 5.6 consequential loss charges as specified in the Liquidated Damages for Non-compliance (Clause 6.3), shall be payable to WPD if the arithmetic mean (hereafter "average") no load loss, or the average load loss of each rating of transformer supplied over six monthly periods exceeds the guaranteed losses. Tolerances are permitted on individual transformers.

6.0 CONNECTION AND PHASE DISPLACEMENT SYMBOLS FOR THREE PHASE TRANSFORMERS

Clause 6 of ENA Technical Specification 35-1 applies.

Clause 6.2 - Single phase 16kVA transformers shall have their lower voltage windings arranged to give a 2-wire supply only.

Clause 6.2 - Single phase 25 and 50kVA transformers shall have their lower voltage windings arranged to give a 2-wire or 3-wire supply. Internal connectors shall not be used.

Single phase transformers of 100kVA shall have their lower voltage windings arranged to give a 3-wire supply.

Clause 6.3 - The method of voltage ratio changeover shall be by means of a switch as detailed in Clause 6.3 with the addition of an anti-vandal cover over the voltage changeover switch which, when in place, shall prevent the changeover switch being operated. The cover shall be lockable in position using a padlock as specified in Clause 6.3. In the case of dual ratio transformers a clear method of indicating which ratio is selected shall be provided, with the ratio left set on 6.6kV.

7.0 RATING PLATES

Clause 7 of ENA Technical Specification 35-1 applies.

Clause 7.2 - Connection plates clearly showing the connections necessary to utilise 2 wire or 3 wire configurations and tapping arrangements shall be provided where appropriate. The neutral terminal shall be clearly identified.

Clause 7.2 - For dual ratio transformers the selected primary voltage shall be clearly identifiable and the tapping voltages given for both 6.6 and 11kV primary voltage. The transformer shall be supplied selected to 6.6kV.

The Rating and Connection plate layout for each type of transformer shall be submitted at the time of tender for approval.

8.0 MISCELLANEOUS REQUIREMENTS

Clause 8.1 - The neutral conductor and terminals shall be of the same rating as the phase conductors and terminals, unless a double rated neutral is specified at the time of tender.

Clause 8.2 - Ground mounted transformers shall be free breathing.

Clause 8.2 - Pole mounted transformers can be either of the options specified. If sealed the over pressure relief valve shall be designed so accidental or easy manual operation of the valve is not possible.

9.0 TOLERANCES

Clause 9 of ENA Technical Specification 35-1 applies.

10.0 TESTS

Clause 10 of ENA Technical Specification 35-1 applies.

Clause 10.1 – Dielectric test levels shall be in accordance with tables 2A and 2B.

Highest voltage for equipment U_m (r.m.s) kV	**Nominal system voltage kV**	**Rated lightening impulse voltage (Li) kV (peak)**	**50 Hz withstand voltage kV (r.m.s)**
1.1 (note1)	0.400/0.230	30	10
1.1	0.400/0.230	-	3
7.2	6.6	75	20
12	11	95	28
24	20	145	50

Table 2A – Insulation levels for pole mounted transformers

Highest voltage for equipment U_m (r.m.s) kV	**Nominal system voltage kV**	**Rated lightening impulse voltage (Li) kV (peak)**	**50 Hz withstand voltage kV (r.m.s)**
1.1	0.400/0.230	-	3
7.2	6.6	75	20
12	11	95	28
24	20	145	50

Table 2B – Insulation levels for all other transformers

Clause 10.1 - The electronic format of the test results shall consist of a tabular format with at least, the following headings:- Serial Number, kVA, Phase, Voltage Ratio, No-load loss - guaranteed, No-load loss - Test, Load loss - guaranteed, Load loss - test, Impedance volts - guaranteed, Impedance volts - test, HV resistance per phase (normal tap), LV resistance per phase (normal tap), date of test.

Clause 10.1.3 - A short circuit type test is likely to be required on one or two of the types being tendered. The cost of these tests shall be identified separately in the tender. Agreement as to which units will be tested will depend on any short circuit type test evidence the supplier has on similar units and will be agreed as part of the post tender negotiations.

11.0 ELECTROMAGNETIC COMPATIBILITY (EMC)

Clause 11 of ENA Technical Specification 35-1 applies.

12.0 TRANSFORMER DETAILS

Clause 12 of ENA Technical Specification 35-1 applies.

Clause 12.2 - The cooling medium shall be unused, uninhibited, naphthenic mineral oil to IEC 60296.

13.0 CONSTRUCTION DETAILS

Clause 13 of ENA Technical Specification 35-1 applies.

The tank lid shall be lipped and designed to shed water.

The transformer tank and accessories shall be designed so as to prevent accumulation of water.

Following cleaning, the interior of the tank above minimum oil level and the underside of the tank cover shall be given one coat of oil-resistant paint or varnish of any medium-to-light colour. This is not necessary for galvanised surfaces.

Clause 13.1 - Nuts and bolts shall be suitably plated to avoid corrosion in the environment detailed in Clause 13.1.

Clause 13.4.1 - A label stating that the transport cap (see Figure 2 of ENA Technical Specification 35-1) should be removed for service and storage shall be prominently displayed near the breather.

Clause 13.4.2 - For pole mounted transformers the oil level indication shall be observable from ground level with or without the aid of binoculars. A simple brightly coloured float within a conventional oil level gauge would suffice.

Clause 13.4.3 - The tapping switch anti-vandal cover shall be suitable for padlocking using a padlock as specified in Clause 5.4.2 of this specification. A label shall be applied adjacent to the taping switch in accordance with Figure 15 Appendix C.

Clause 13.4.6 - All Ground mounted transformers shall be fitted with a combined drain and sampling valve, 25mm outlet with a 1" BSP internal thread complete with a screwed blanking plug with hexagonal head. Pole mounted transformers will not have any oil sampling facilities.

Clause 13.4.7 - Lifting fittings shall be fitted as specified in parts 2 to 4 of ENATS 35-1. The lifting eyes shall retain all their properties and functionality for the lifetime of the transformer and shall be painted yellow.

Clause 13.4.8 - The under base of ground mounted transformer tanks shall incorporate two parallel skids on the underside running the majority of the length of the tank to provide a stable base that will be suitable for use with sound absorbing pads. The skids shall be provided with 42mm diameter axle holes for one axle at each end. Fitting of rollers of maximum diameter 200mm shall not be inhibited by the under base extension.

14.0 DOCUMENTATION

Clause 14 of ENA Technical Specification 35-1 applies.

Clause 14.1 - Format of electronic drawings shall be Autocad DWG.

15.0 CABLE CONNECTED TRANSFORMERS

Clause 15 of ENA Technical Specification 35-1 applies.

Clause 15.1 - Option A shall be required with the addition that the 250mm clearance either side of the centre line of the HV cable box shall be increased to 300mm i.e. a total clearance of 600mm.

Clause 15.2 - Facings and internal connections shall be provided for mounting an HV cable box but no cable box shall be supplied. The flange facing shall be to Figure 24, Facing 'E' of BS 2562:1979. The HV flange shall project 30mm. The flange shall be fitted with a non-returnable blanking plate of minimum thickness 3mm complete with gasket for transport purposes.

Clause 15.3 - The relevant cast resin bushing assembly shown in BS2562:1979 Figure 16 shall be provided. The flange facing shall be to Figure 25, facing 'F' of BS2562:1979. The LV flange shall project a minimum of 55mm.

Clause 15.4 - An oil level gauge shall be provided.

The tapping switch shall be supplied set to Tap Position 3 and a label saying so attached nearby.

16.0 UNIT SUBSTATION TRANSFORMERS

Clause 16 of ENA Technical Specification 35-1 applies.

Clause 16.1 - Any extension of the under base shall be suitable for fitting the same sound absorbing pads as under the main tank (Clause 13.4.8).

Clause 16.2 - A gasket for the transformer/ring main equipment interface is not required.

Clause 16.4 - An oil gauge shall be provided. The oil gauge, rating and connection plates, the oil drain and sampling valve and the plain breathing device shall be approximately on the same vertical as the earth tag and tapping switch shown in Figure 7 of ENA Technical Specification 35-1 so as to ensure they are not obscured when the LV cabinet and ring main equipment is fitted.

17.0 TESTS FOR UNIT SUBSTATION TRANSFORMERS

Clause 17 of ENA Technical Specification 35-1 applies.

18.0 POLE MOUNTED TRANSFORMERS

Clause 18.1 - Pole mounted transformers rated above 50kVA will not be required to have single-bolt fixing.

Clause 18.1 - Dimension C in Figures 11 and 12 shall be reduced to 605mm for 100kVA single and 3 phase and 200kVA 3 phase pole mounted transformers as Note 3.

The maximum weight of any platform mounted transformer shall be 1400kg.

The maximum weight of any transformer with single bolt fixing shall be 400kg.

Clause 18.2 - All terminations for pole-mounted transformers shall be outdoor-oil immersed bushings in accordance with IEC 60137 and table 3 below. Bushings shall be suitably rated for the transformer currents.

Voltage (kV)	Live Metal to Earth Flashover distance (mm)	Air end creepage distance (mm)	Phase to Phase Clearance (mm)	Stem Diameter (mm)	Stem Length (mm)
<1.1	58	90	77	12 or 20	56 or 70
7.2/12	203	406	254	12 or 16	60
24	266	600	305	12 or 16	60

Note 1: Live metal to earth clearances are to be achieved with arcing horns removed.

Table 3: - Bushings, Connections and Clearances.

Clause 18.2.1 - The overall height of the transformer and bushings shall be in accordance with figures 10 - 12.

HV surge arresters shall be provided The HV surge arresters shall be approved by the purchaser.

Clause 18.2.2 - For platform mounted pole mounted transformers the LV bushings shall be mounted on the tank side opposite to that of the higher voltage bushings.

Clause 18.2.2 - Single phase transformers up to and including 50kVA will be selectable for 2 or 3 wire operation - connection plates will clearly identify the connections necessary to convert from 2 wire to 3 wire operation. 16kVA transformers will be 2 wire only. 100kVA single phase transformers will be 3 wire only.

Clauses 18.2.1 and 18.2.2 - The preferred terminal markings will be, when viewed from left to right, as shown below.

Transformer	**HV**	**LV**
1ph, 2 wire	A8, A1	a1, a2
1ph, 2 or 3 wire	A8, A1	a1, a3, a2, a4
3ph	A8, B8, C8	c2, b2, a2, yn

Consideration will be given, at the time of tender, to the terminal markings given in ENA Technical Specification 35-1.

Clause 18.2.2 - A neutral surge arrestor and mounting bracket shall be provided (Bowthorpe EMP Transient Voltage Clamper, TVC-1 or equivalent).

19.0 PAD MOUNTED TRANSFORMERS

19.1 Pad mount transformers are a compact low profile ground mounted transformer for use where space is a premium or in areas of outstanding natural beauty where an overhead distribution system may not be appropriate. They will be used as a tee-off substation between two conventional ring main units. They shall be compliant with ANSI C57-12-25/26

19.2 The general clauses of this specification will apply to padmounts as applicable. The standard sizes given in Table 4 will be required:-

kVA	**No. of phases**	**Voltage Ratio**	**ELSP Fuse Rating**	**Bay-o-net Fuse Rating**	**Outgoing fuseways**
50 kVA	1	11,000 : 250 V	15.5kV 40A	12A	400A 1 way 1 phase
50 kVA	1	11,000 : 250-0-250 V	15.5kV 40A	12A	400A 1 way 2 phase
100 kVA	1	11,000 : 250-0-250 V	15.5kV 50A	15A	400A 2 way 2 phase
50 kVA	3	11,000 : 433-250 V	15.5kV 30A	5A	400A 1 way3 phase
100 kVA	3	11,000 : 433-250 V	15.5kV 40A	12A	400A 2 way 3 phase
200 kVA	3	11,000 : 433-250 V	15.5kV 100A	25A	400A 2 way 3 phase

Table 4 - Padmount Details

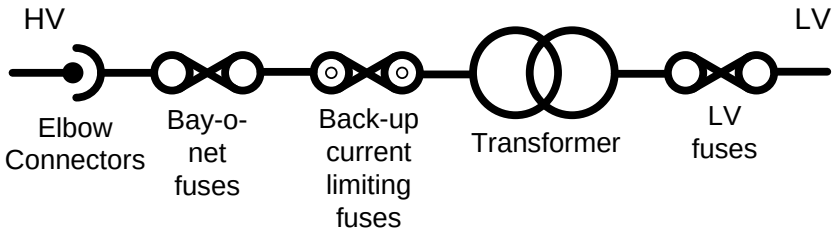
19.3 Padmount transformers will have the following parameters.

Network Parameter	12kV Network	1.1kV LV Network
Nominal voltage	11,000 V	250 V
Lightning impulse (peak)	95 kV	-
Power frequency withstand for 1 minute	28 kV	10 kV

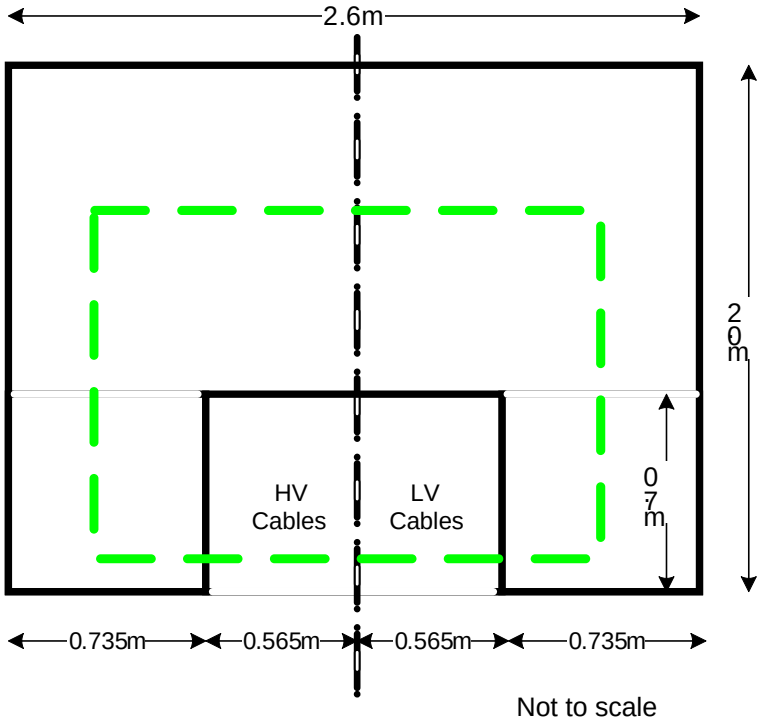
19.4 Padmounts with a rating of 200kVA or below shall not be equipped with corrugated tanks or radiators. Lower losses than those calculated to optimise capitalisation or maximum loss requirements may be necessary.

19.5 Preferred padmount impedances shall be under 3%.

19.6 ELSP Current-Limiting Backup Fuses shall be fitted within the transformer tank and will not necessarily be readily accessible. The sizes required are given in Table 4. Schematically the padmount shall be as shown below:



19.7 The padmount will be suitable for mounting on the plinth drawing given below:



19.8 The maximum dimensions of all sizes of padmount will be 1800mm wide, 1300mm deep and 1200mm tall. Consideration will also be given to a taller unit if this suits the manufacturers design. Any upwardly opening covers shall be designed that the maximum height of the unit with the covers open, or partially open, shall be 2100mm.

19.9 The padmount shall have two separate compartments one HV and one LV. The HV and LV compartment shall be on the same side of the transformer with the LV compartment on the right.

19.10 The LV compartment shall be lockable with a padlock of the following dimensions: body up to 63 mm square, 6 to 10mm diameter shackle having a clear inside width of 35 mm and an inside length of between 25 mm and 45 mm. The hole provided for the shackle shall be not less than 12 mm diameter. The compartment shall also be locked off using a penta head bolt with the housing capable of taking a padlock as detailed above.

19.11 The HV compartment shall be lockable as follows:-

a) Externally using a padlock and
b) Bolted closed with two bolts and
c) Interlocked from within the LV compartment.

It shall be possible to lock a) and c) with a padlock of the following dimensions: body up to 41mm square, 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.

19.12 The HV compartment shall house:-

a) Cooper 200A 15kV Class Load-break Bushing Insert fitted with protective caps. Sufficient clearance shall be provided to allow cables to be connected using Cooper 200A Load-break Elbow Connectors when all doors/covers are closed. Sufficient access shall be required to allow unplugging / plugging of the load break elbows using a gripall stick.

b) A parking bracket adjacent to each load break bushing, suitable to hold a Cooper 200A Load-break Rotatable Feed thru Insert. Sufficient clearance shall be provided to allow Cooper 200A Load-break Elbow Connectors to be connected to the Feed thru Insert when all doors/covers are closed.

c) Cooper "Bay-O-Net" fuse assemblies fitted with dual element fuses as detailed in Table 4 and fitted with drip trays.

d) HV tapping switch as detailed in Clause 5.4.2. An anti-vandal cover shall not be required.

e) An earth bar.

19.13 The LV compartment shall house:-

a) Oil level gauge

b) Free breather

c) Rating Plate

d) LV outgoing ways generally to ENA Technical Specification 37-2 Issue 4 as appropriate. Current rating and number of ways is detailed Table 4. The outgoing contacts shall be fitted with M10 x 45 HEX HD screw, spacing washer, 2 x plain washers and shake proof washer to accept cable lugs suitable to terminate 95 or 185mm² Wavecon cable to BS7870 Pt3.40.

e) A female 600A 'Litton' connector (or equivalent) shall be provided on the neutral/earth bar to allow the safe connection of generator cables onto a live padmount.

f) Ideally 'Litton' connectors (or equivalent) shall be provided on each phase for the safe connection of generator cables onto a live padmount, but it is appreciated that space/access may prevent this. If it is possible to fit these connectors the extra cost of doing so should be identified separately at the time of tender.

APPENDIX A

ENA Technical Specification 35-1 - Self Certification Conformance Declaration for Distribution Transformers shall be completed by the tenderer.

APPENDIX B

SPECIFICATION FOR WPD 12kV DISTRIBUTION TRANSFORMERS

TECHNICAL SCHEDULE (To be completed by the Tenderer)

MANUFACTURER:-

Continuous rating in accordance with BS171-1978						
1	Continuous rated kVA at	5^oC ambient temp % 10^oC ambient temp %				
2	Type of core material					
3	Method of core clamping					
4	Max. flux density Wb/m^2	cores yoke				
5	Fixed losses at nominal ratio (Iron) watts					
6	Load losses at 75^oC nominal ratio and rated kVA (Copper) watts					
7	Current density in windings	HV amps / sq cm LV				
8	Regulation at 75^oC rated kVA and nominal ratio	(a) Unity p f (b) 0.8 p f lag				
9	Impedance volts at 75^oC and rated kVA	(a) Max. tap (b) Nominal ratio (c) Min. tap				
10	Types of winding	(a) HV (b) LV (c) Location of tapping section (d) If foil - method of making foil termination				
11	Insulation of	(a) HV winding*/material (b) LV winding*/material (c) tapping (d) tapping connection (e) core bolts (f) core bolt washers (g) side plates (h) core laminations				
	* If foil - state number of papers between layers					

Continuous rating in accordance with BS171-1978						
12	Calculated thermal time constant					
13	Tank thickness	(a) sides (b) bottom (c) top-plate (d) radiators	mm mm mm mm			
14	Total oil required		litres			
15	Proposed supplier and type of oil					
16	Volume of oil to be removed to enable change of cable box		litres			
17	Weight of core and winding assembly		Kg			
18	Total weight including oil		Kg			
19	Outline drawing number (typical)					
20	Envelope dimensions (over-cable boxes, where applicable)		Height mm			
			Width mm			
21			Length mm			
22	Noise level dBA from type test					
23	Type of bushings, if non ESI 35-1 stem diameters and materials					
24	Thickness of galvanising/zinc spray (specify which)					
	Proposed paint system: numbers and types of coats and dry film thicknesses					

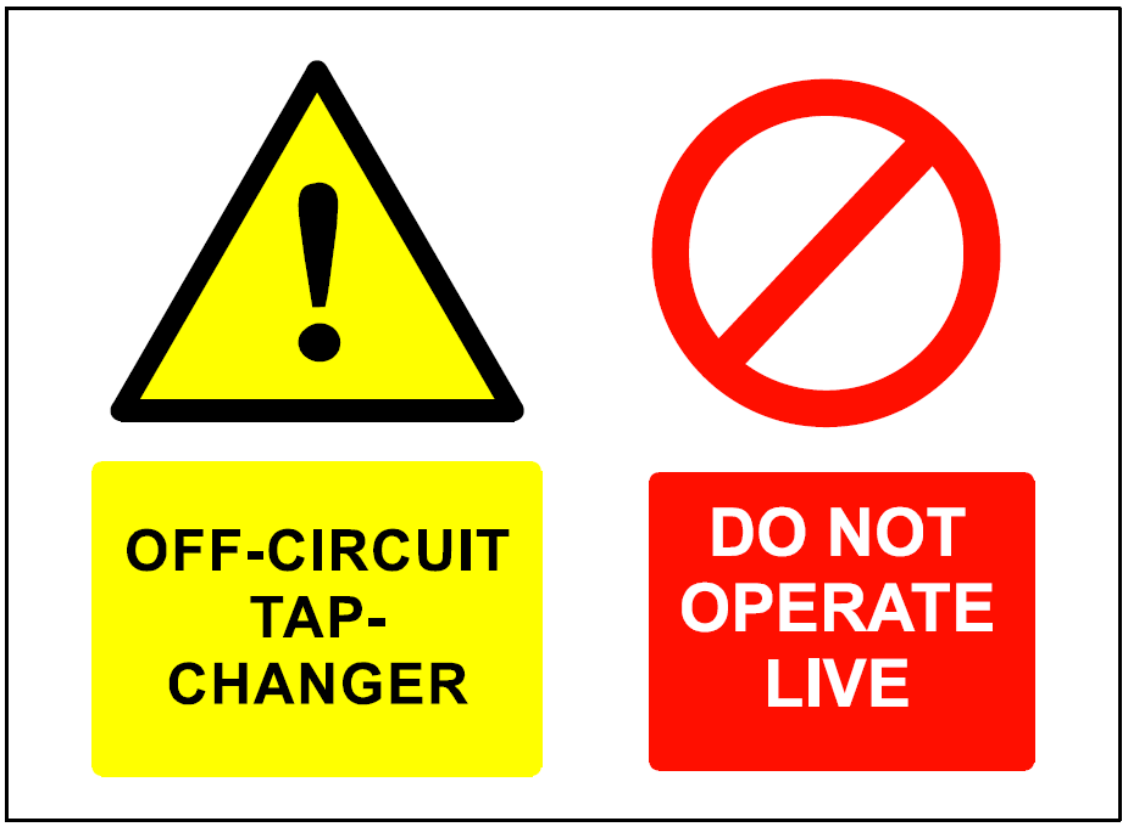


Fig. 15. Warning Label For Off-Circuit Tapping Switch And Voltage Ratio Change Switch

APPENDIX D

SUPERSEDED DOCUMENTATION

EE SPEC: 5/4 dated July 2013 is superseded on the issue of this document.

APPENDIX E

ASSOCIATED DOCUMENTATION

ENATS 35-1 2007
ANSI C57-12-25/26
IEC60076
ECO Directive 2009/125/EC

APPENDIX F

IMPACT ON COMPANY POLICY

Update of specification in line with the latest national and international specifications and standards.
The inclusion of the new European eco directive transformer losses

APPENDIX G

IMPLEMENTATION OF POLICY

This document shall be implemented on issue.

APPENDIX H

KEYWORDS

Distribution Transformer, Padmount, Pole Mounted, Ground Mounted.