WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 206

11kV Distribution Transformers with Non-oil Based Fluid for Electric Car Charging Hubs and Other Special Applications

Policy Summary
This specification covers the requirements for 1000kVA and 1600kVA three phase Distribution Transformers with non-oil based fluid for connection to Western Power Distribution's network and to be used to provide supplies to electric car charging hubs.

Author: **Andrew Reynolds**

Implementation Date: **January 2022**

Approved by

Carl Ketley-Lowe
Engineering Policy Manager

Date: **20th January 2022**

Target Staff Group	**Electricity System Development; Purchasing; Engineering Policy**
Impact of Change	**Amber**
Planned Assurance checks	**As these are initially to be used for development application then the DNO Engineering Policy Team will ensure compliance with this EESPEC on an ongoing basis.**

IMPLEMENTATION PLAN

Introduction

This document defines the special application 11/.433 Distribution Transformers considered for use within Western Power Distribution (WPD) and provides a standard with which can be used to purchase trial and development units.

Main Changes

This is a new specification produced to permit the trial and development of a new unit style substation arrangement in order to provide supplies to single customer car charging hub sites.

This transformer specification is not for general use in any other application on the WPD network.

Impact of Changes

This new specification will have no impact on business as usual as it is to enable the purchase of initial units for trial and development purposes only.

Implementation Actions

The Electricity System Development Team will work with Procurement and Engineering Policy to procure units required for trial and development purposes.

The Electricity System Development Team will work with selected local 11kV planners to identify suitable sites for trial of the arrangement detailed in EESPEC 208, of which this transformer will form part.

Engineering Policy will create new CROWN templates as required.

Implementation Timetable

To be used for tenders following the issue date.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
January 2022	• New specification	Andrew Reynolds / Stephen Hennell

Contents

1.0 SCOPE

This Enginering Equipment Specificaiotn covers the technical requirements for three phase Distribution Transformers with non-oil based fluid for connection to Western Power Distribution's network, to be used to provide supplies to electric car charging hubs.

This specification is limited to 50Hz, naturally cooled 1000kVA and 1600kVA units for continuous service and suited to indoor or outdoor application.

[*Note: Whilst this EESPEC has been written to include a 1.6MVA transformer option, this is not available for use until aspects of ENA Rec P2 are being reviewed/revised***.]**

It is based on ENA Technical Specification 35-1 Issue 6 - June 2014.

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).

ENATS 35-1 Part 1 Issue 2014 Common clauses
ENATS 35-1 Part 2 Issue 2014 Ground mounted transformers-not close coupled
ENATS 35-1 Part 3 Issue 2014 Ground mounted transformers-close coupled

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.

The three phase transformer shall be connected Delta-Star, in accordance with vector group reference Dyn11 of IEC 60076.

The transformer shall achieve losses that are 10% less than Tier 2 as detailed in European Eco Directive 2009/125/EC.

PART A COMMON CLAUSES

All Clauses of this section are as ENA Technical Specification 35-1 Issue 6 Part 1

3.0 DEFINITIONS

Clause 3 of ENA Technical Specification 35-1 part 1 applies.

4.0 SERVICE CONDITIONS

Clause 4 of ENA Technical Specification 35-1 part 1 applies.

5.0 RATING AND GENERAL REQUIREMENTS

Clause 5 of ENA Technical Specification 35-1 part 1 applies.

5.1.2 **Preferred values of rated power**

The standard rated powers, rated voltages and impedance shall be as per Table 1 ENA Technical Specification 35-1 part 1.

6.0 REQUIREMENTS FOR TRANSFORMERS HAVING A TAPPED WINDING

Clause 6 of ENA Technical Specification 35-1 part 1 applies.

Clause 6.4 the tapping specifications shall meet the relevant parts of ENA TS 35-1 parts 2, 3 and 4.

Clause 6.6 - 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. Also conforming to Regulation No 548/201.

The energy performance of all transformers supplied as part of this engineering specification shall be at its ONAN rating and shall comply with the max allowed values of load losses and no load losses for Tier 2 further reduced by a factor of 10%.

Losses stated below are Tier 2 losses further reduced by a factor of 10%. It is WPD's intention to only use transformers that meet or are lower than the loss levels of Table 1 below.

Three phase rating - kVA	**1000**		**1600**	
	Tier 2	Tier 2 -10%	Tier 2	Tier 2 -10%
No Load Loss (W)	693	624	1980	1782
Load Loss (W)	7600	6840	13000	11700

Table 1 - Three phase ground mounted transformer losses

Clause 6.6 - In addition to the requirements of Clause 6.6 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.

6.6.1 Dual ratio transformers

The load loss shall be guaranteed at 11000V condition but measured in both 11000V and 6600V conditions.

7.0 CONNECTION AND PHASE DISPLACEMENT SYMBOLS FOR THREE PHASE TRANSFORMERS

Clause 7 of ENA Technical Specification 35-1 applies.

8.0 RATING PLATES

Clause 8 of ENA Technical Specification 35-1 applies.

Clause 8.3 - 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.

9.0 SAFETY, ENVIRONMENTAL AND OTHER REQUIREMENTS

9.2 - 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.

9.3 - Ground mounted transformers shall be free breathing.

9.5 **Centre of gravity**

Clause 9.5 of ENA Technical Specification 35-1 part 1 applies.

10.0 TOLERANCES

Clause 10 of ENA Technical Specification 35-1 part 1 applies.

11.0 TESTS

Clause 11.1 of ENA Technical Specification 35-1 applies.

11.1.1 General

11.1.1 Of ENA Technical Specification 35-1 part 1 applies

Dielectric test levels shall adhere to the values required for each transformer type Specified in Parts 2-4 of this specification

11.1.2 Routine tests

Clause 11.1.2 Of ENA Technical Specification 35-1 part 1 applies see Table 2.

IEC 60076-1 routine tests	Test(s)	Comment
11.2.1 a), b), c), d)	Measurement of: winding resistance; voltage ratio and phase displacement; short-circuit impedance and load loss; no –load loss and current	Required
11.2.1 e)	Dielectric test	Required – see Table 3
11.2.1 f)	Test on energised tap-changers	NOT required
11.2.1 g)	Leak testing with pressure for liquid-immersed	Required
11.2.1 h)	Tightness and pressure for gas-filled	NOT required
11.2.1 i), j)	Check of: ratio and polarity of CTs; core and frame insulation	Required, where fitted

Table 2 – Transformer routine tests

IEC 60076-3 dielectric tests	Test	Comment
7.3.1.1 a)	Applied voltage test (AV)	Required
7.3.1.1 b)	Induced voltage withstand test (IVW)	Required

Table 3 – Transformer dielectric tests

11.1.3 Type tests

Clause 11.1.3 of ENA Technical Specification 35-1 part 1 shall apply

12.0 ELECTROMAGNETIC COMPATIBILITY (EMC)

Clause 12 of ENA Technical Specification 35-1 part 1 applies.

14 Transformer details

14.2 Surface finish

Clause 14.2 ENA Technical Specification 35-1 part 1 applies.

15 Documentation

Clause 15 ENA Technical Specification 35-1 part 1 applies.

16 Breather

The transformer shall either be fitted with a moisture-removing breather arrangement or be a sealed unit so as to prevent the ingress of moisture into the insulating fluid. A sealed unit is preferred so as to minimise the required maintenance activity.

PART B GROUND MOUNTED TRANSFORMERS – CLOSE COUPLED DESIGN

This part must be read in conjunction with Part A.

4 Additional requirements for ground mounted transformers – close coupled

4.1 General

Ground mounted transformers shall be of close coupled design and shall either be configured as per layout option d) of ENA Technical Specification 35-1 part, or be of an alternate configuration designed to achieve a compact overall footprint when combined with HV and LV equipment as in WPD EESPEC 208, EEPEC 207 & EESPEC 16.

Any close coupled design shall comply with the limiting dimensions indicated in Figure 3 of ENA Technical Specification 35-1 part 3

4.3 HV terminations

4.3.1 General

HV phase markings shall be 1U, 1V, 1W and shall be provided on the transformer side face.

4.3.2 HV cable box

HV cable box is not permitted.

4.3.3 HV separable connectors

HV separable connections are not permitted.

4.3.4 HV ring main unit

Clause 4.3.4 of ENA Technical Specification 35-1 part 3 applies.

Note that the HV switchgear shall be limited to a single circuit breaker arrangement as specified in EESPEC 208. No ring switch disconnectors are to be permitted to be provided in the HV switchgear attached to these transformers. This may be of benefit in formulating alternate designs.

4.4 LV terminations

Clause 4.4 of ENA Technical Specification 35-1 part 3 shall apply

4.4.1 General

LV phase markings shall be 2W, 2V, 2U, 2N. LV terminations shall be in accordance with ENA TS 35-1 part 3 Clause 4.4.1.

4.4.2 LV cable box

LV cable box are not permitted.

4.5 Connection and phase displacement

Three phase transformers shall be connected delta-star, in accordance with vector group Dyn11.

4.6 Specification of tappings

All three-phase transformers shall be provided with a de-energised tap-changer. Tappings shall be provided on the higher voltage winding for a variation of no load primary voltage of -5% -2.5%, 0%, +2.5% and +5%.

4.6.1 Dual ratio transformers

Clause 4.6.1 of ENA TS 35-1 part 3 applies

4.6.2 Tapping/ratio position locking

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.

4.7 Fittings

Clause 4.7 of ENA Technical Specification 35-1 part 3 shall apply.

4.7.1 General

The requirements of ENA TS 35-1 clause 14.5 shall apply.

All fittings shall not be obstructed.

5 Tests for ground mounted – close coupled

5.1 Dielectric test levels

Clause 5.1 – Dielectric test levels shall be in accordance with table 1 of ENA TS 35-1 part 2.

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

Table 4 – Insulation levels for ground mounted transformers

5.2 Temperature rise test

The temperature rise test shall be carried out with the transformer fitted with assemblies that represent the HV switchgear and the LV transformer mounted cabinet specified in EESPEC 208.

See ENA TS 35-1 part 3 page 16 onwards for limiting drawings and arrangement drawings.

PART C PAD MOUNT TRANSFORMERS

1 General

1.1 For this special application pad mount transformers provide a compact low profile ground mounted transformer for use where space is a premium.

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 and exceed by 10% the losses requirements of the eco directive 2009/125EC No 548/2014.

1.2 The general clauses of this specification will apply to padmounts as applicable. The standard sizes given in Table 5 will be required:-

kVA	No. of phases	Voltage Ratio	ELSP Fuse Rating	Bay-o-net Fuse Rating	Outgoing LV arrangement
1000	3	11,000 : 433-250 V	165A [CBUC15165D100]	100A [4000353C16M]	Equivalent to LV transformer mounting cabinet "TMC 16/-/CB16" of EESPEC 16. No other arrangements are permitted eg additional LV fuseways.

Table 5 - Padmount Details

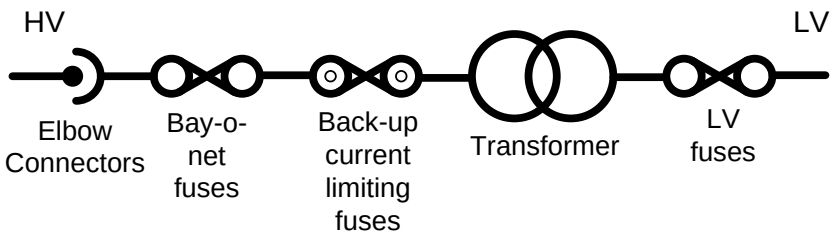
1.3 Padmount transformers will have the following parameters.

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

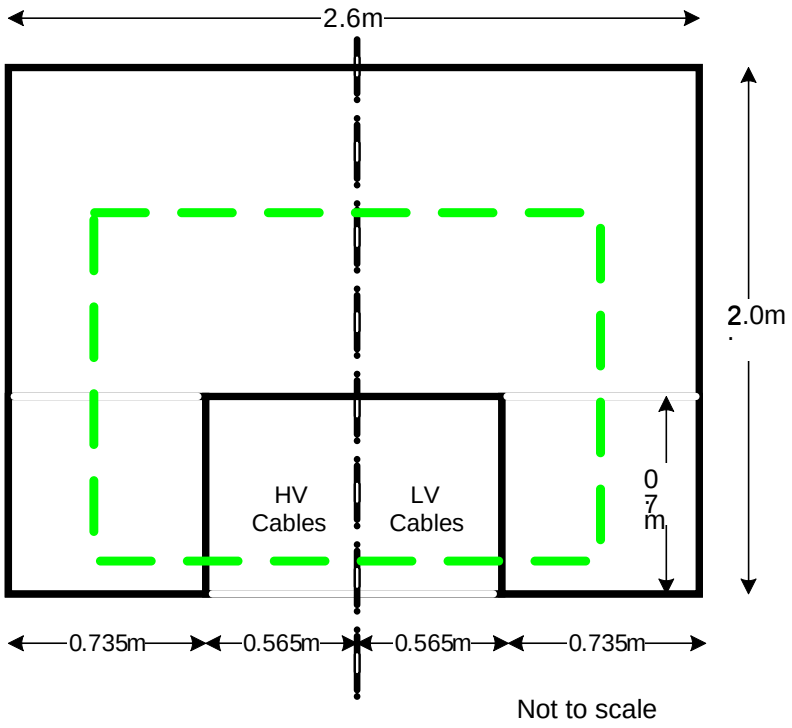
1.5 Preferred pad mount impedances shall be 4.75%.

1.6 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:



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



1.8 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 or is technically required. Any upwardly opening covers shall be designed that the maximum height of the unit with the covers open, or partially open, shall be 2100mm.

1.9 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.

1.10 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.

1.11 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.

1.12 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.

Movement of the connectors from the load break bushing to the parking position shall not require the disassembly of the glands or gland plate/s.

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.

1.13 The LV compartment shall house:-

a) Oil level gauge

b) Free breather

c) Rating Plate

d) An LV arrangement that is equivalent to TMC 16/-/SCC of Table 1c in EESPEC 16. No additional LV ways shall be provided or enabled.

e) Female 600A **'**Litton' connectors (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.

1.14 The overall padmount housing shall not provide any ready means of climbing or allow for easy interference with component parts.

Cooling shall be by means of the provision of a corrugated tank and not by bolt-on radiators.

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°C ambient temp % 10°C 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°C nominal ratio and rated kVA (Copper) watts					
7	Current density in windings	HV amps / sq cm LV				
8	Regulation at 75°C rated kVA and nominal ratio	(a) Unity p f (b) 0.8 p f lag				
9	Impedance volts at 75°C 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					

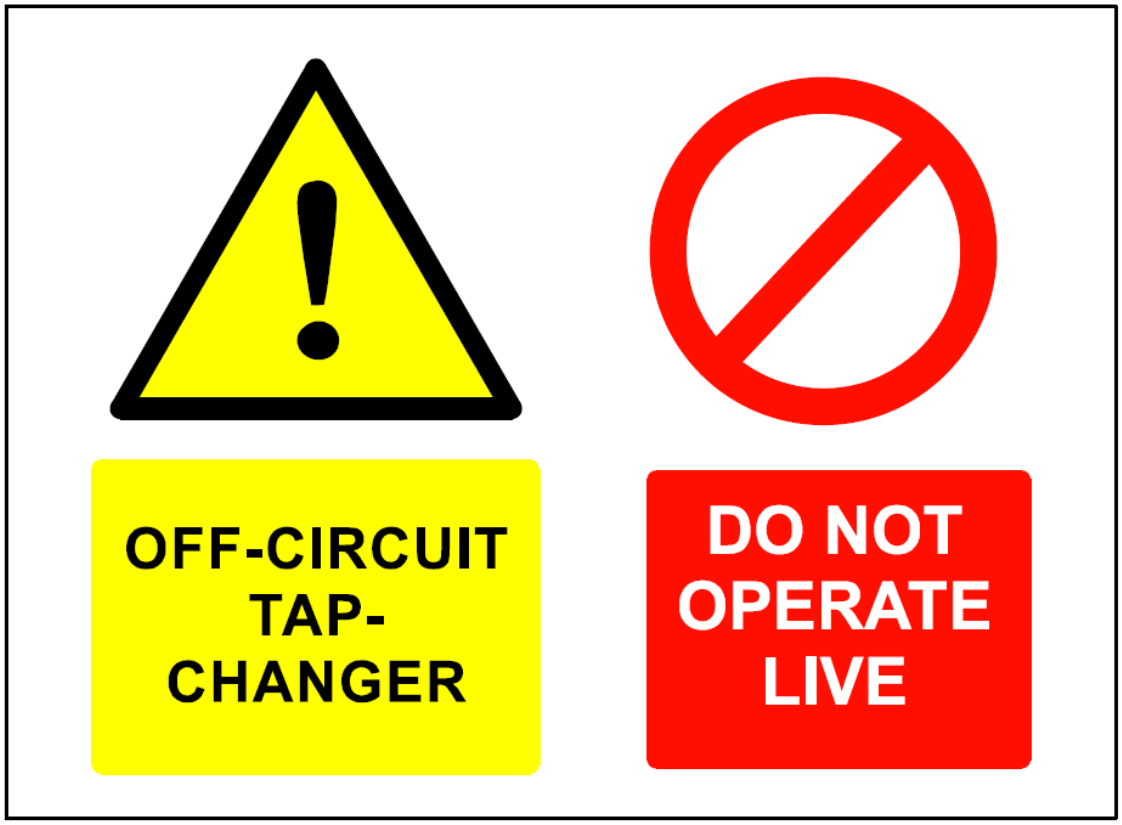


Fig. 15. Warning Label For Off-Circuit Tapping Switch And Voltage Ratio Change Switch

APPENDIX D

SUPERSEDED DOCUMENTATION

No documentation is superseded as this is a new specification.

APPENDIX E

RECORD OF COMMENT DURING CONSULTATION

No comments received.

APPENDIX F

ASSOCIATED DOCUMENTATION

ENATS 35-1 2014
ANSI C57-12-25/26
IEC60076
ECO Directive 2009/125/EC No 584/2014
EESPEC 207 "*Outdoor Freestanding Low Voltage Feeder Pillar to provide SNE connections to Multiple EV Car Charging Hubs*"
EESPEC 208 "*Unitised Assembly of Transformer, LV Transformer Mounted Cabinet and 12kV Switchgear, including Housing, as a Complete Unit for Direct to Site Delivery"*
EESPEC 16 "*LV Distribution Fuseboards*"

APPENDIX G

IMPACT ON COMPANY POLICY

There is no impact on existing WPD Policies, Standard Techniques or Engineering Equipment Specifications.

APPENDIX H

IMPLEMENTATION OF POLICY

This document shall be available for use on issue.

APPENDIX I

KEY WORDS

Distribution Transformer, Padmount, Ground Mounted, Car Charging Hub