NPS/003/011 – Technical Specification for Ground Mounted Distribution Transformers up to and including 20kV

1. Purpose

The purpose of this specification is to detail the technical requirements of Ground mounted Distribution Transformers for use on the distribution networks of Northern Powergrid up to and including 20kV.

This document supersedes the following documents, all copies of which shall be destroyed.

Reference	Version	Date	Title
NPS/003/011	7.0	Oct 2020	Technical Specification for Ground Mounted Distribution Transformers up to and including 20kV.

2. Scope

This specification covers the technical requirements for Ground mounted Distribution Transformers with de-energised tap-changers utilised on the Northern Powergrid's 11kV, 20kV and legacy voltage distribution networks. This includes a requirement for suppliers to provide periodic inspection and maintenance information.

This specification does NOT apply to:

- Pad Mount Transformers,
- Pole-Mounted Distribution Transformers, or
- Transformers with on-load tap-changers

each of which have their own specification.

Ground mounted Distribution Transformers with lid mounted HV and LV bushings are acceptable to Northern Powergrid, providing they comply with section 3.3.1 of this specification.

The following appendices form part of this technical specification;

Appendix 1 - Variations to ENA TS 35-1 Part 2 Figure 2 and to ENA TS 35-1 Part 3 limitations on radiator arrangements

Appendix 2 - Declaration of Compliances

Appendix 3 - Schedule of Requirements

Appendix 4 - Addendum to Supplier Requirements

Appendix 5 - Inspection and Maintenance Requirements

Appendix 6 - Summary of Test Requirements

Appendix 7 - Technical Information Check List

Technical documents referenced within this specification refer to the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENA TS) current at the time of supply.

Any subsequent changes in the relevant International Standards, British Standard Specifications and Energy Networks Association Technical Specifications (ENA TS) which result in a variation from this specification shall be incorporated by suppliers, subject to a technical evaluation by Northern Powergrid Policy and Standards Section and instruction in writing.

2.1. Table of Contents

3. Technical Requirements

3.1. Overview

The requirement is for Ground mounted Transformers to be utilised on the 11 and 20kV distribution networks of Northern Powergrid.

There are occasional requirements for other primary voltages (for example 6.6kV, 3.3kV, etc.) for use on legacy parts of the network. Transformers required for use on these networks shall comply with relevant parts of this specification.

Northern Powergrid invite offers for super low loss transformers that exceed Regulation (EU) No 548/2014 Ecodesign Tier 2 (and potentially Tier 3) performance, for example amorphous core transformers. All transformers shall comply with the appropriate losses requirement at the time of supply.

Ground mounted distribution transformers are required for use in substations configured for different layouts; these being:

- Unit Substation Style (Close-coupled transformer) – where HV and LV connections are on the same face of the transformer. 11kV switchgear and/or LV switchgear can be directly connected. Both HV and LV switchgear can also be interchanged with a cable box.
- Cable Connected (Not close-coupled transformer) – where HV and LV connections are on opposite side faces of the transformer. HV and/or LV switchgear can be directly connected, or cable connected, to the transformer.

Some transformers are required for use in particularly onerous situations adjacent to electricity transmission towers where higher levels of insulation are required in line with Energy Networks Association Engineering Recommendation G78-3 'Recommendations for Low Voltage Supplies to Mobile Phone Base Stations with Antennae on High Voltage Structures'.

3.2. Technical Specification

3.2.1. General

The equipment shall comply with the following Energy Networks Association Technical Specifications:

- Energy Networks Association Technical Specification (ENA TS 35-1, Part 1 2020 – Distribution Transformers – Common clauses
- Energy Networks Association Technical Specification (ENA TS 35-1, Part 2 2014 – Distribution Transformers – Ground mounted transformers—not close-coupled
- Energy Networks Association Technical Specification (ENA TS 35-1, Part 3 2014 – Distribution Transformers – Ground mounted transformers—close-coupled

The electrical insulating fluid shall meet the technical requirements of NPS/003/019.

Ground mounted Transformers with lid mounted bushings are acceptable providing they meet the requirements of sections 3.3.1 and 3.3.2 of this specification.

Regardless of configuration arrangements, Ground mounted Transformers shall not have unscreened HV conductors outside the transformer tank and shall not have exposed LV outside the transformer tank.

The equipment shall also comply with the latest versions of all other relevant, IEC International Standards, British Standard Specifications or equivalent Euro-Norms and Energy Networks Association Technical Specifications (ENA TS) at the time of supply, except where varied by this standard.

Any subsequent changes in the relevant International Standards, British Standard Specifications and Energy Networks Association Technical Specifications (ENA TS) which result in a variation from this specification shall be incorporated by suppliers, subject to a technical evaluation by Northern Powergrid Policy and Standards Section and instruction in writing.

3.2.2. Variations and Clarifications to ENA TS 35-1

The following are intended to highlight or are additional requirements to ENA TS 35-1, therefore the Clause numbers in this section relate to ENA TS 35-1 Parts 1, 2 or 3 and are represented in italics:

ENA TS 35-1 Part 1 Common Clauses

Part 1 - 3.13.1 (Definitions) Types of Transformer

Not close-coupled – "A transformer having HV and LV flanges on opposite sides of the transformer for mounting cable boxes on the flanges."

The transformer shall also be designed and constructed such that an LV fuse cabinet and/or a HV Ring Main Unit can be directly mounted on the respective LV and HV flanges and assembled in such a manner that the whole substation can be handled, transported and installed as a unit.

Part 1 - 6.0 Specifications of Tappings

Transformers supplied with a Single Ratio Primary to Secondary winding are required to offer five tapping positions providing a variation of no-load Primary voltage of:

-5%, -2½ %, 0, +2½ % and +5 %

Dual ratio Transformers supplied with an 11kV and second legacy voltage HV winding of ~6kV are required to offer five tapping positions providing a variation of no-load Primary voltage of:

-5%,-2½ %, 0, +2½ % and +5 % on the 11 000V winding, and

- A range specific to the surrounding legacy network requirements that will be agreed at the time of order on the lower ratio HV winding.

For the removal of doubt, the principal tapping is the middle of the range, in accordance with IEC 60076-1.

The transformer shall be supplied equipped with a label adjacent to the tap changing switch that states the tap range. On Dual ratio transformers, both tap ranges shall be stated on the rating plate.

Part 1 - 6.6 Losses

Transformers shall be optimised for lifetime costs which shall be calculated, by the supplier, using the formula in Appendix 4 of this specification and the latest Northern Powergrid capitalisation figures provided at the tender stage.

Part 1 - 11.0 Testing

A summary of the testing requirements and classification is given in Appendix 6 of this NPS document.

Part 1 – 11.1.1 (Tests) General, Insulation Levels for all Other Transformers

The rated Lightning Impulse (LI) for 11kV equipment shall be at least 95kV (peak).

Part 1 – 11.1.3 Type Tests

Unless existing test evidence is available and is formally accepted by Northern Powergrid, the full range of type tests required by ENA TS 35-1 shall be performed on, at least, the first unit of a given type and rating from a production facility.

Part 1 – 11.1.4 Special Tests

Unless existing test evidence is available and is formally accepted by Northern Powergrid, a short-circuit withstand test in accordance with IEC 60076-1 Clause 11.1.4 shall be performed on, at least, the first unit of a given type and rating from a production facility.

Part 1 – 5.2 Cooling Mode

Where transformers contain insulating fluid, this fluid shall comply fully with the current version of Northern Powergrid Specification NPS/003/019 – Specification for Electrical Insulating Fluids for use in Plant and Equipment.

Part 1 – 14.2 Surface Finish

The surface finish colour shall be mid grey. Other colours will be considered, subject to formal agreement by Northern Powergrid.

ENA TS 35-1 Part 2 Ground Mounted Transformers-Not Close-Coupled

Part 2 - General

The arrangement and limiting dimensions shall be as specified in ENA TS 35-1, Part 2 Figures 2 and 3. The design of the transformer shall allow for the HV and/or LV switchgear to be directly connected to the transformer if required. This shall include provision for the HV flange and transformer face to accept and support either a HV cable box or a directly coupled RMU in the same manner as the Unit Transformer specified in clause 6.205 of ENA TS 41-41

The transformer shall return to the upright position when tilted 20° from the vertical, in any direction, with or without the overturning loads from the Ring Main Unit and the LV fuse cabinet (assuming the loadings shown in Fig 7 of ENA TS 35-1 Part 3, but with HV and LV switchgear on opposite sides of the transformer).

The test for transformer returning upright does not need to include the weight of the operator.

The transformer tank with its cover removed shall be capable of withstanding the combined load of the ring main equipment and LV distribution cabinet without distortion.

The transformer shall be supplied equipped with lifting fittings to suit slings or shackles, of adequate design to facilitate lifting in a reasonably upright position:

i. With or without HV and LV cable boxes.

ii. Complete with HV ring main equipment and/or LV distribution fuse-cabinet having weight distributions as shown in fig. 9 (but omitting the weight of the operator).

Any combination of two of these lifting fittings shall be capable of supporting (with a factor of safety of at least two) the combined weight of the: transformer, HV ring main equipment and LV distribution fuse cabinet, when oil-filled as for service.

Part 2 – 4.3 HV Terminations

The option shall be provided for a stable fixing for an ENA TS 41-36 and ENA TS 41-41 compliant HV ring main equipment provided by supports fixed to the tank side in accordance with fig. 8.of ENA TS 35-1, Part 3.

The HV Flange Type shall be “TYPE E” to BS 2562 (Up to and including 11kV) and “TYPE J” to BS 2562 (20kV).

The steelwork shall be capable of supporting the HV ring main equipment and the operator, having a load distribution as shown in fig. 9, detail ‘A’.

The terminal flanges shall be positioned as detailed in fig. 4 of ENA TS 35-1 Part 3.

Where no cable box is supplied connected, the HV flange shall be supplied equipped with a non-returnable blanking plate of minimum thickness 5mm complete with gasket for transport purposes, together with a 5mm gasket supplied loose for permanent use for the transformer/ring main equipment / cable box interface.

The HV flange and supporting steelwork for the Ring Main Unit shall be in the same plane (reference plane) in order to facilitate connection of the Ring Main Unit. This reference plane shall be not less than 50mm and not more than 75mm from the tank wall.

The option for an HV cable box, which complies with ENA TS 12-11, shall be provided.

The cable box shall be supplied equipped with a gland plate and three CES4 glands (or equivalent) suitable for use with single core cables, each of which shall enter the cable box vertically below its termination bushing.

The cable box shall also be supplied equipped with a suitably rated insulated bushing that is designed to allow the three HV cable earth screens to be connected to it inside the cable box and a connection from the substation earth to be connected to it outside the cable box.

HV cable connections shall be made utilising standard lug connections OR screened separable connectors. Bushings for HV cable connections rated up to and including 24kV, shall be outside cone type (non-load-break) interface C1 (630A) in accordance with BSEN 50180.

HV cable connections other than in accordance with BS EN 50180 will be considered; but these arrangements will be formally assessed by Northern Powergrid before being accepted.

HV cable connections that do not incorporate a fully rated metallic earth screen shall be enclosed by an earth-bonded metal cover that:

a) When installed on the transformer provides physical protection, tested to 5J impact at the most vulnerable point on all exposed sides and at the vulnerable point on each exposed edge.

b) Provides a minimum IP rating of IP21B in accordance with IEC 60529. For the purposes of this test, the separable connector is to be classed as a hazardous part that requires 20mm clearance from the end of the IP21B test probe.

Part 2 – 4.4 LV Terminations

The cast resin bushing assembly shown in BS 2562, 1979, figure 16, shall be provided.

The transformer shall be capable of supporting an LV distribution fuse-cabinet complying with ENA TS 37-2 having a load distribution as shown in fig. 7, Detail 'B' of ENA TS 35-1 – Part 3.

The LV cable box flange shall be positioned as detailed in fig. 4 of ENA TS 35-1 – Part 3.

The temperature rise test shall be carried out with the transformer fitted with assemblies that represent a HV Ring Main Unit and an LV fuse cabinet, both of which shall be close-coupled to the transformer.

The option for providing an LV cable box, in accordance with ENA TS 12-11, is required.

Part 2 and 3 – 4.7.2 Combined Drain and Sampling Valve

Transformers that are not hermetically sealed shall be supplied equipped with a combined drain and sampling valve.

Part 2 and Part 3 – 4.7.5 Jacking Lugs

Four jacking lugs shall be provided at 190mm ±5mm above ground level. There shall be clear access to engage a jack with the lug as given in Figure 1; with a deviation of height from 400mm to 190mm on the Side view.

Part 2 and 3 – 4.7.6 Manual Handling

Transformer design shall take into account and shall allow for methods of manual handling including, but not limited to, the use of a pinch bar and 50-75mm diameter rollers.

Transformers shall be designed and constructed to allow the fitting of axles/wheels; and the subsequent removal, or locking, of the wheels once the transformer is in position.

ENA TS 35-1 Part 3 Ground Mounted Transformers—Close-Coupled

Part 3 - 4.1 General

The test for transformer returning upright does not need to include the weight of the operator.

Part 3 – 4.3 HV Terminations

The HV flange shall be supplied equipped with a non-returnable blanking plate of minimum thickness 5mm complete with gasket for transport purposes, together with a 5mm gasket supplied loose for permanent use for the transformer/ring main equipment interface.

The HV Flange Type shall be “TYPE E” to BS 2562 (Up to and including 11kV) and “TYPE J” to BS 2562 (20kV).

The HV flange face and the supporting steelwork for the Ring Main Unit shall be in the same plane (reference plane) in order to facilitate connection of the Ring Main Unit. The reference plane shall be not less than 50 mm and not more than 75 mm from the tank wall.

Northern Powergrid requires the option for the transformer to be equipped with HV connections and cable box as per 15.2 above in Clause 3.3.2

Part 3 – 4.4 LV Terminations

The cast resin bushing assembly shown in BS 2562, 1979, figure 16, shall be provided.

The option for an LV cable box, in accordance with ENA TS 12-11, shall be provided.

Part 2 and 3 – 4.7.2 Combined Drain and Sampling Valve

Transformers that are not hermetically sealed shall be supplied equipped with a combined drain and sampling valve.

Part 2 and Part 3 – 4.7.5 Jacking Lugs

Four jacking lugs shall be provided at 190mm ±5mm above ground level. There shall be clear access to engage a jack with the lug as given in Figure 1; with a deviation of height from 400mm to 190mm on the Side view.

Part 2 and 3 – 4.7.6 Manual Handling

Transformer design shall take into account and shall allow for methods of manual handling including, but not limited to, the use of a pinch bar and 50-75mm diameter rollers.

Transformers shall be designed and constructed to allow the fitting of axles/wheels; and the subsequent removal, or locking, of the wheels once the transformer is in position.

3.3. Special Requirements

3.3.1. HV and LV Bushing Arrangements

In addition to the close-coupled and non-close coupled types detailed in ENA TS 35-1, arrangements where HV and/or LV terminations are mounted on the tank cover will be considered by Northern Powergrid.

If tank cover mounted HV and/or LV bushings are offered this must be clearly stated in Appendix 2.

HV cable connections shall be made as detailed in ENA TS 35-1, Part 3 section 4.3

For HV cable connections rated up to and including 24kV, the Interface shall be 630A bushings Type C1 to BS EN 50180

HV cable connections shall also be enclosed by an earth-bonded metal cover that:

a) When installed on the transformer provides physical protection, tested to 5J impact at the most vulnerable point on all exposed sides and at the vulnerable point on each exposed edge.

b) Provides a minimum IP rating of IP21B in accordance with IEC 60529. For the purposes of this test, the separable connector is to be classed as a hazardous part that requires 20mm clearance from the end of the test probe.

Tank mounted LV connections shall be insulated and shall be enclosed by an earth-bonded metal cover that:

a) When installed on the transformer provides physical protection, tested to 5J impact at the most vulnerable point on all exposed sides and at the vulnerable point on each exposed edge.

b) Provides a minimum IP rating of IP4XB in accordance with IEC 60529. For the purposes of this test, the LV insulation is to be classed as a hazardous part that requires 20mm clearance from the end of the test probe.

3.3.2. G78 Transformers

Northern Powergrid requires a small number of transformers that will be used to provide Low Voltage supplies to mobile phone base stations with antennae on High Voltage structures and these transformers shall comply with the requirements of Energy Networks Association's Engineering Recommendation EREC G78

G78 installations in Northern Powergrid are designed to withstand a 29kV 50Hz rise of earth potential (ROEP).

G78 transformers shall be supplied equipped with surge arrestors between the HV connections and the transformer tank. The surge arrestors shall provide the following characteristics:-

SURGE ARRESTOR CHARACTERISTICS	For use on 11kV network	For use on 20kV network
Rated Voltage	36kV	41kV
Line Discharge	Class 2	Class 2
Nominal Discharge Current	10kA	10kA
Minimum Transient Overvoltage	36kV	41.5kV
Maximum Residual Voltage (when subjected to a 10kA 8/20µs lightning current impulse)	100kV	140kV

G78 transformers shall be supplied equipped with an external electrical bond between the neutral terminal and the transformer tank earth connection. This bond shall have a minimum cross sectional of 70mm^2 copper, or equivalent.

For G78 transformers the electrical characteristics shall be enhanced to the following minimum insulation levels:

	LV (<1kV)	12kV	24kV
Rated lightning impulse withstand voltage (BIL, peak)	---	125kV	175kV
Rated 1 min power frequency wet withstand	3kV	36kV	50kV

3.3.3. Other Legacy Voltage System Transformers

Northern Powergrid utilises a small number of transformers on its Legacy networks. These shall generally comply with the requirements of this specification and the relevant parts of ENA TS 35 series. The most common of these are;

- 7.2kV transformers for use on Northern Powergrid 5.25 - 6.6kV networks and,
- 3.6kV transformers for use on Northern Powergrid 3kV networks, which shall have the following dielectric characteristics:

Rated lightning impulse withstand voltage (LI)	$40kV_{peak}$
Rated power frequency withstand	10kV

3.3.4. Distribution Transformers for Special Applications

Transformers for applications where there is an unacceptable risk of fire, environmental sensitivity or environmental risk shall be supplied filled with high flash point fluid, which shall be in accordance with NPS/003/019 and have been approved by Northern Powergrid.

3.3.5. Distribution Transformers with On Load Tap Changers

It is anticipated that there will be a future requirement for distribution transformers with on-board automatic voltage control to counter the effects of increased embedded generation and demand. This will come in the form of distribution transformers which will incorporate an on load tap-changer (OLTC) in lieu of a standard de-energised tap-changer (DETC). This will be a significantly more complicated tap-changer utilising voltage sensing instruments and an intelligent microprocessor based controller linked to SCADA than has traditionally been found on distribution transformers; typically de-energised manual type. Therefore OLTCs are excluded from the scope of the ENA TS 35-1 series of specifications.

Distribution transformers with OLTC is included within the scope of issue (2) of ENA TS 35-7 – *Tap-changers for system voltages up to and including 132kV*, and will be the subject of a separate Northern Powergrid Technical Specification; NPS/003/044.

4. References

4.1. External Documentation

The products described within this specification shall comply with the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENA TS) current at the time of supply

Reference	Title
BS 2562, 1979	Cable Boxes For Transformers And Reactors
BS EN 50180-1: 2015	Plug-in type bushings above 1kV up to 52kV and from 250A to 3,15kA for liquid filled transformers. General requirements for bushings
COMMISSION REGULATION (EU) No 548/2014	Ecodesign requirements for Power transformers with a minimum rating of 1kVA used in 50Hz electricity transmission and distribution networks or for industrial applications.
ENA ER G78-4, Issue 4 2018	Recommendations for Low Voltage Supplies to Mobile Phone Base Stations with Antennae on High Voltage Structures
ENA TS 35-7, Issue 2 2020	Tap-changers for system voltages up to and including 132 kV
ENA TS 41-41, Issue 1 2020	Ground Mounted Distribution Substation 12 to 24 kV Rated RMU & Extensible Switchgear
ENA TS 12-11, Issue 5 2018	Dry Cable Terminations In HV Switchgear For Service At Rated Voltages 12, 24 And 36kV
ENA TS 37-2, Issue 5 2012,	LV distribution fuse-boards, “Public Electricity Network Distribution Assemblies”
ENA TS 41-36, Issue 3 2012	Distribution Switchgear For Service Up To 36kV (Cable And Overhead Conductor Connected)
ENA TS 35-1, Part 1 2020	Distribution Transformers – Common clauses
ENA TS 35-1, Part 2 2014	Distribution Transformers – Ground mounted transformers—not close-coupled
ENA TS 35-1, Part 3 2014	Distribution Transformers – Ground mounted transformers—close-coupled
IEC 60076 series	Power Transformers
IEC 60529, 1992	Degrees of Protection Provided by Enclosures

4.2. Internal Documentation

Reference	Title
IMP/001/103	Code of Practice for the Methodology of Assessing Losses
NPS/003/019	Technical Specification for Electrical Insulating Fluids for use in Plant & Switchgear.
NPS/003/044	Technical Specification for Ground mounted Voltage regulated distribution transformers incorporating on load tap-changers up to and including 20kV.
NPS/006/002	Technical Specification for Distribution Substation Enclosures

4.3. Amendments from Previous Version

Clause	Subject	Amendments
3.3.5	Voltage Regulated Distribution Transformers	Clause added to inform that OLTC will be a separate NPS in line with ENA TS 37-2
4.	References	Updated to include ENA TS 37-2 and ENA TS 41-41, and 2020 version of 35-1 Part 1
4.2	Internal Documentation	Updated to include Distribution Transformers with on load tap changer specification
Appendix 3	Schedule of Items tables	Added column for transformer Core type to be stated
Appendix 6	Summary of Test Requirements	Corrected numbering references to 60076-1 test clauses

5. Definitions

Term	Definition
None	

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	01/07/2021

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years	Non Standard Review Period and Reason	
No	Period: 5 Years	Reason: Update will be dictated by contract renewal date or any significant changes in the specification or documents referenced.
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Alan MacDonald	Policy and Standards Engineer	02/07/2021

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
Joseph Helm	Policy and Standards Manager	05/07/2021
Anuj Chhettri	Smartgrid Development Engineer	02/07/2021
Steve White	Plant Resource Engineer	27/07/2021

6.4. Authorisation

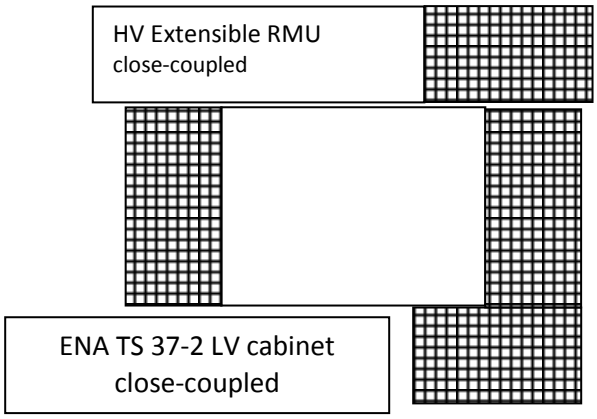
Authorisation is granted for publication of this document.

Paul Black	System Engineering Manager	13/07/2021

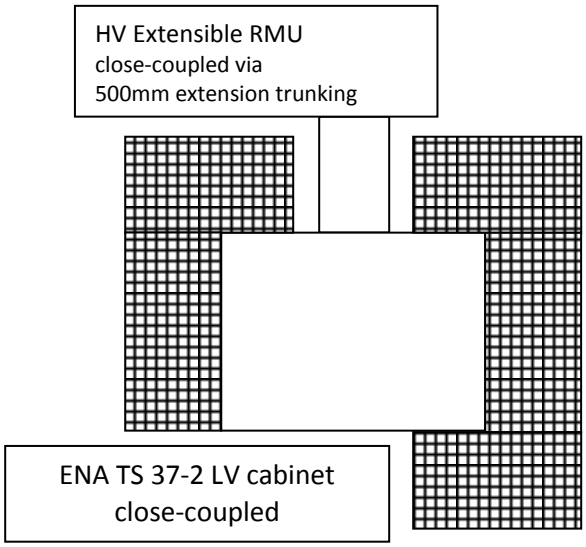
Appendix 1 - ENA Variations to ENA TS 35-1 Part 2 Figure 2

Limitations on Radiator Arrangements

For units up to and including 1000kVA the limiting dimensions of the transformer shall be:



For units with a rating above 1000kVA up to and including 1600kVA the limiting dimensions of the transformer shall preferably be as the diagram above, but may be:



Appendix 2 Self-Certification Declaration of Conformances

Appendix 2a Conformance with NPS/003/011

CLAUSE BY CLAUSE CONFORMANCE WITH Northern Powergrid Technical Specification NPS/003/011

The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.

Conformance declaration codes*

NA	Clause is not applicable or appropriate to the product
Cs1	the product fully conforms with the requirements of this clause
Cs2	the product partially conforms with the requirements of this clause
Cs3	the product does not conform with the requirements of this clause
Cs4	the product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to comply.

Instructions for completion

Entries shall be made in the remarks column for ALL clauses and sub-clauses.

This shall include an explanation of why it does conform (including reference to type tests) or why it does not conform.

Manufacturer:		
Product Reference:		
Name:	**Signature:**	**Date:**

NPS/003/011 — Self-Certification Conformance Declaration

Clause/Sub-clause	Requirement	Schedule item	Remarks
3.1	Overview	N/A	
3.2.1	General	N/A	
3.2.2	Variations and Clarifications to ENA TS 35-1		
3.2.1 – Part 1 – 3.13.1	Types of Transformer - Not close-coupled	LV fuse cabinet and/or a HV Ring Main Unit can be directly mounted on the respective LV and HV flanges	
3.2.1 - Part 1 - 6.0	Specifications of tappings	-5%,-2½ %, 0, +2½ %, and +5 %	
3.2.1 - Part 1 - 6.6	Losses	The supplier shall calculate the lifetime costs using the formula in Appendix 4 of this specification	
3.2.1 - Part 1 – 11.0	Testing	Summary of tests required	
3.2.1 - Part 1 – 11.1.1	Testing general	The rated Lightning Impulse (LI) for 11kV equipment shall be at least 95kV (peak).	
3.2.1 - Part 1 – 11.1.3	Type tests	Complete set of type tests completed	
3.2.1 - Part 1 – 11.1.4	Special tests	short circuit withstand test in accordance with IEC 60076-1 Clause 11.1.4 shall be performed	

Clause/Sub-clause	Requirement	Schedule item	Remarks
3.2.1 - Part 1 – 5.2	Cooling mode	Compliance with the current version of Northern Powergrid Specification NPS/003/019	
3.2.1 - Part 1 – 14.2	Surface finish	The surface finish colour shall be mid grey	
3.2.1 - Part 2 – 15.1	General	Compliance with general requirements	
3.2.1 - Part 2 – 4.3	HV terminations	Requirement for HV ring main equipment provided by supports fixed to the tank side in accordance with ENA TS 35-1, Part 3	
3.2.1 - Part 2 – 4.3	LV terminations	The cast resin bushing assembly shown in BS 2562, 1979, figure 16, shall be provided.	
3.2.1 - Part 2 and 3 – 4.7.2	Combined drain and sampling valve	Transformers that are not hermetically sealed shall be supplied equipped with a combined drain and sampling valve.	
3.2.1 - Part 2 and 3 – 4.7.5	Jacking lugs	Dimension and position of jacking lugs	
3.2.1 - Part 2 and 3 – 4.7.6	Manual handling	Requirement to allow the unit to be manoeuvred manually	
3.2.1 - Part 3 – 4.1	General	N/A	
3.3.1	Special arrangements for HV and LV bushings	Type and position of terminations	
3.3.2	G78 transformers	Units used to provide Low Voltage supplies to mobile phone base stations with antennae on High Voltage structures	
3.3.3	Legacy system voltage requirements	The availability of units for legacy system voltages	
3.3.4	Transformers for special applications	Transformers cooled with high flash point fluid	
Appendix 1	Limitations on radiator arrangements	Positional compliance	

Appendix 2b Conformance with ENA TS 35-1 Parts 1, 2 and 3

CLAUSE BY CLAUSE CONFORMANCE WITH ENA TS 35-1 Parts 1, 2 and 3.

Transformers covered by ENA TS 35-1 shall comply with the latest issues of the relevant International and British Standards. ENA TS 35-1 is intended to amplify and/or clarify the requirements of those Standards.

This check sheet identifies the clauses in ENA TS 35-1 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*

NA	Clause is not applicable or appropriate to the product
Cs1	the product fully conforms with the requirements of this clause
Cs2	the product partially conforms with the requirements of this clause
Cs3	the product does not conform with the requirements of this clause
Cs4	the product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to comply.

Instructions for completion

Entries shall be made in the remarks column for ALL clauses and sub-clauses.

This shall include an explanation of why it does conform (including reference to type tests) or why it does not conform.

Manufacturer:		
Product Reference:		
Name:	**Signature:**	**Date:**

ENA TS 35-1, Part 1 — Self-Certification Conformance Declaration

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 1	Schedule item	Remarks
1	Scope			N/A	
2	Normative references			N/A	
3	Terms and definitions		N/A	N/A	
3.1	General		N/A	N/A	
3.2	Terminals and neutral point		N/A	N/A	
3.3	Windings		N/A	N/A	
3.4	Rating		N/A	N/A	
3.5	Tappings		N/A	N/A	
3.6	Losses and no-load current		N/A	N/A	
3.7	Short-circuit impedance and voltage drop		N/A	N/A	
3.8	Temperature rise		N/A	N/A	
3.9	Insulation		N/A	N/A	

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 1	Schedule item	Remarks
3.10	Connections		N/A	N/A	
3.11	Test classification		N/A	N/A	
3.12	Meteorological data with respect to cooling		N/A	N/A	
3.13	Types of transformer	N/A		Type of transformer offered	
4	Service conditions	N/A		N/A	
4.1	General			N/A	
4.2	Normal service conditions		N/A	N/A	
5	Rating and general requirements		N/A	N/A	
5.1	Rated power		N/A	N/A	
5.1.1	General		N/A	N/A	
5.1.2	Preferred values of rated power	N/A		Rated power (kVA)	
5.1.3	Minimum power under alternative cooling modes		N/A	N/A	
5.1.4	Loading beyond rated power		N/A	Overload rating percentage	
5.2	Cooling mode		N/A	Liquid details	
5.3	Load rejection on transformers directly connected to a generator	N/A	N/A	N/A	N/A
5.4	Rated voltage and rated frequency		N/A	N/A	
5.4.1	Rated voltage		N/A	HV rated voltage (V) LV rated voltage (V)	
5.4.2	Rated frequency		N/A	Rated frequency (Hz)	
5.4.3	Operation at higher than rated voltage and/or at disturbed frequency		N/A	N/A	
5.5	Provision for unusual service conditions				
5.6	Highest voltage for equipment U_m and dielectric test levels				
5.7	Additional information required for enquiry				
5.7.1	Transformer classification	N/A		N/A	
5.7.2	Winding connection and number of phases	N/A		Specify details if applicable	
5.7.3	Sound level	N/A		N/A	

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 1	Schedule item	Remarks
5.7.4	Transport		N/A	N/A	
5.8	Components and materials		N/A	N/A	
6 6.1	Requirements for transformers having a tapped winding General—Notation of tapping range			N/A	
6.2	Tapping voltage—tapping current, etc.		N/A	N/A	
6.3	Tapping power—full power tappings—reduced power tappings	N/A		N/A	
6.4	Specification of tappings in enquiry and order	N/A		N/A	
6.5	Specification of short-circuit impedance			Guaranteed Impedance (%) Impedance (%) for 33 kV transformers	
6.5.1	Single-phase transformer arranged to give a 3-wire supply	N/A		N/A	
6.6	Load loss and temperature rise			Maximum no-load loss (W) Maximum load loss (W) or Peak Efficiency Index (PEI) % Regulation (EU) No 548/20: Tier 1 compliance? Tier 2 compliance? Loss capitalization values: No-load loss (£/kW) Load loss (£/kW)	
				Temperature rise Oil (°C) Windings (°C)	
6.6.1	Dual ratio transformers	N/A		N/A	
7	Connection and phase displacement symbols		N/A	N/A	
8	Rating plates		N/A	N/A	
8.1	General		N/A	N/A	
8.2	Information to be given in all cases		N/A	N/A	
8.3	Additional information to be given when applicable			N/A	

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 1	Schedule item	Remarks
9	Safety, environmental and other requirements		N/A	N/A	
9.1	Safety and environmental requirements		N/A	N/A	
9.2	Dimensioning of neutral connection	N/A		Dimensioning of neutral connection	
9.3	Liquid preservation system	N/A		N/A	
9.4	DC currents in neutral circuits			Level of d.c. currents (A)	
9.5	Centre of gravity	N/A		N/A	
10	Tolerances		N/A	N/A	
11	Tests		N/A	N/A	
11.1	General requirements for routine, type and special tests			N/A	
11.1.1	General			N/A	
11.1.2	Routine tests			N/A	
11.1.3	Type tests			Sound Power Level (dBA)	
11.1.4	Special tests			Special tests included in the offer	
11.2	Measurement of winding resistance		N/A	N/A	
11.3	Measurement of winding ratio and phase displacement		N/A	N/A	
11.4	Measurement of short-circuit impedance and load loss		N/A	N/A	
11.5	Measurement of no-load loss and current		N/A	N/A	
11.6	Measurement of zero-sequence impedance(s) on 3-phase transformers		N/A	N/A	
11.7	Tests on on-load tap changers	N/A	N/A	N/A	N/A
11.8	Leak testing with pressure for liquid immersed transformers (tightness test)		N/A	N/A	
11.9	Vacuum deflection test for liquid immersed transformers		N/A	N/A	
11.10	Pressure deflection test for liquid immersed transformers		N/A	N/A	
11.11	Vacuum tightness test on site for liquid immersed transformers		N/A	N/A	
11.12	Check of core and frame insulation		N/A	N/A	
12	Electromagnetic compatibility (EMC)		N/A	N/A	
13	High frequency switching transients		N/A	N/A	

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 1	Schedule item	Remarks
14	Transformer details	N/A		N/A	
14.1	Number of phases	N/A		N/A	
14.2	Surface finish	N/A		Finish colour offered	
14.3	Position and marking of terminals	N/A		N/A	
14.4	Cooling	N/A		Method of liquid preservation	
14.5	Other fittings	N/A		N/A	
14.5.1	Plain breathing device	N/A		N/A	
14.5.2	Tapping switch handle	N/A		N/A	
14.5.3	Earthing terminals	N/A		N/A	
14.5.4	Lifting fittings	N/A		N/A	
15	Documentation	N/A		N/A	
15.1	Drawings	N/A		Electronic drawing format	
15.2	Assembly, operations and maintenance instructions	N/A		Electronic format for instruction manual	
15.2.1	Test data	N/A		N/A	

ENA TS 35-1, Part 2 — Self-Certification Conformance Declaration

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 2	Schedule item	Remarks
2	Normative references			N/A	
3	Terms and definitions			N/A	
3.1	PENDA-TMO			N/A	
3.2	TFX – fusebox			N/A	
4	Additional requirements for ground mounted transformers—not close-coupled	N/A			
4.1	General	N/A		Layout option for not close-coupled transformer	
4.2	Lifting and mechanical properties	N/A		N/A	
4.3	HV terminations	N/A		Type of termination provided	
4.3.1	General	N/A		N/A	
4.3.2	HV side face terminations	N/A		Termination option for side face	
4.3.2.1	HV cable box	N/A		Specification of cable box	

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 2	Schedule item	Remarks
4.3.2.2	HV flange	N/A		Specification of flange Description of flange blanking plate	
4.3.2.3	HV separable connectors	N/A		Specification of termination	
4.3.3	HV top cover terminations	N/A		Specification of terminations Option for cable clamps	
4.4	LV terminations	N/A		Type of termination provided	
4.4.1	General	N/A		N/A	
4.4.2	LV side face terminations	N/A		Bushing plate assembly or cast resin bushing assembly. Cable box fitted or not	
4.4.2.1	LV cable box	N/A		N/A	
4.4.3	LV top cover terminations	N/A		Metal enclosure specification	
4.5	Connection and phase displacement	N/A		Connection symbol	
4.6	Specification of tappings	N/A		Tapping range offered	
4.6.1	Dual ratio transformers	N/A		Method of the voltage ratio change	
4.6.2	Tapping/ratio position locking	N/A			
4.7	Fittings	N/A		N/A	
4.7.1	General	N/A			
4.7.2	Combined drain and sampling valve	N/A		N/A	
4.7.3	Tapping switch handle security	N/A		Description of provision for tapping handle security	
4.7.4	Liquid level indication	N/A		Description of provision for external liquid level indicator	
4.7.5	Jacking lugs	N/A		–Height above ground 190mm ± 5mm	
4.7.6	Manual handling	N/A		Description of provision for manual handling	
4.7.7	Earthing terminals	N/A		N/A	
5	Tests for ground mounted transformers—not closed-coupled	N/A		N/A	
5.1	Dielectric test levels	N/A			

ENA TS 35-1, Part 3 — Self-Certification Conformance Declaration

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 3	Schedule item	Remarks
2	Normative references			N/A	
3	Terms and definitions			N/A	
3.1	PENDA-TMO			N/A	
4	Additional requirements for ground mounted transformers—close-coupled	N/A		N/A	
4.1	General			Layout option for close-coupled transformer	
4.2	Lifting and mechanical properties	N/A		Method of stabilising transformer	
4.3	HV terminations	N/A		Type of termination provided	
4.3.1	General	N/A		N/A	
4.3.2	HV cable box	N/A		N/A	
4.3.3	HV separable connectors	N/A		Specification of termination	
4.3.4	HV ring main equipment	N/A		Description of flange blanking plate	
4.4	LV terminations	N/A		N/A	
4.4.1	General			Bushing plate assembly or cast resin bushing assembly Requirement for cable box	
4.4.2	LV cable box	N/A		N/A	
4.5	Connection and phase displacement	N/A		N/A	
4.6	Specification of tappings	N/A		Tapping range offered	
4.6.1	Dual ratio transformers			Method of voltage ratio change	
4.6.2	Tapping/ratio position locking	N/A		N/A	
4.7	Fittings	N/A		N/A	
4.7.1	General	N/A		N/A	
4.7.2	Combined drain and sampling valve	N/A		N/A	
4.7.3	Tapping switch handle security	N/A		Description of provision for tapping handle security	
4.7.4	Liquid level indication	N/A		Description of provision for external liquid level indicator	
4.7.5	Jacking lugs	N/A		Height above ground 190mm ± 5mm	
4.7.6	Manual handling	N/A		Description of provision for manual handling	
4.7.7	Earthing terminals	N/A		N/A	

Clause/Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-1 Part 3	Schedule item	Remarks
5	Tests for ground mounted transformers—close-coupled	N/A		N/A	
5.1	Dielectric test levels	N/A		N/A	
5.2	Temperature rise test	N/A		N/A	

Appendix 3 Schedule of Requirements

Many of the items in the following schedules have additional minor variants with alternative unique codes to differ between being supplied with alternative ancillaries for example cable boxes, or flange blanking plates. This is indicated where there is more than one Northern Powergrid code in that column.

	11kV – Unit Transformers (UDE Type) - HV and LV Flanges on the same Transformer face															
Northern Powergrid Code	Description	Manufacturer's Reference and Drawing Number	Core Type (state)	Maximum No Load Losses Fe (kW)	Maximum Load Losses Cu (kW)	Impedance (%)	Positive Sequence Resistance (%)	Zero Sequence Resistance (%)	Zero Sequence Reactance (%)	Free Breathing Or other	Insulating Fluid (Make and Type)	Volume of fluid (Litres)	Total Mass of Transformer (kg)	Dimensions		
														L (mm)	W (mm)	H (mm)
382610 380400	**315 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															
380265 380401	**500 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															
380279 380402	**800 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															
380258 380403	**1000 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															
380627 380404	**1250 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															
380629 380405	**1600 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															
380630 380406	**2000 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															
380631 380407	**2500 kVA**, 11,000V-433V, 3 phase, UDE Type, Ground Mount Tx															

NOTE: Impedance, Resistance and Reactance values shall be supplied to, at least, two decimal places

11kV - Cable Connect type - HV and LV Flanges on opposite Transformer faces

Northern Powergrid Code	Description	Manufacturer's Reference and Drawing Number	Core Type (state)	Maximum No Load Losses Fe (kW)	Maximum Load Losses Cu (kW)	Impedance (%)	Positive Sequence Resistance (%)	Zero Sequence Resistance (%)	Zero Sequence Reactance (%)	Free Breathing Or other	Insulating Fluid (Make and Type)	Volume of fluid (Litres)	Total Mass of Transformer (kg)	Dimensions		
														L (mm)	W (mm)	H (mm)
381073 380408	**315 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV type, Ground Mount Tx															
381092 380409	**500 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
381121 380410	**800 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
381125 380411	**1000 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
384248 380412	**1250 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
380995 380413	**1600 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
380622 380414	**2000 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
380625 380415	**2500 kVA**, 11,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															

NOTE: Impedance, Resistance and Reactance values shall be supplied to, at least, two decimal places

20kV - Cable Connect type - HV and LV Flanges on opposite Transformer faces

Northern Powergrid Code	Description	Manufacturer's Reference and Drawing Number	Core Type (state)	Maximum No Load Losses Fe (kW)	Maximum Load Losses Cu (kW)	Impedance (%)	Positive Sequence Resistance (%)	Zero Sequence Resistance (%)	Zero Sequence Reactance (%)	Free Breathing Or other	Insulating Fluid (Make and Type)	Volume of fluid (Litres)	Total Mass of Transformer (kg)	Dimensions		
														L (mm)	W (mm)	H (mm)
381770	**315 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
381799	**500 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
381838	**800 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
381858	**1000 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
384375	**1250 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
381875	**1600 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
380632	**2000 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															
380633	**2500 kVA**, 20,000V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx															

NOTE: Impedance, Resistance and Reactance values shall be supplied to, at least, two decimal places

		Dual Ratio 11kV/6kV - Cable Connect type - HV and LV Flanges on opposite Transformer faces																		
Northern Powergrid Code	Description	Manufacturer's Reference and Drawing Number	Core Type (state)	Guaranteed Maximum No Load Losses Fe (kW)	Guaranteed Maximum Load Losses Cu (kW)	HV Tap Connection	Voltage Connection Type	Maximum No Load Losses Fe (kW)	Maximum Load Losses Cu (kW)	Tapping Range	Impedance (%)	Positive Sequence Resistance (%)	Zero Sequence Resistance (%)	Zero Sequence Reactance (%)	Free Breathing Or other	Insulating Fluid (Make and Type)	Volume of fluid (Litres)	Total Mass of Transformer (kg)	Dimensions		
																			L (mm)	W (mm)	H (mm)
DUAL500-11-5.5-CC	**500 kVA**, 11,000/5,500V-433V, 3 phase, Cable connected HV and Close-coupled LV type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,500V-433V														
DUAL500-11-5.75-CC	**500 kVA**, 11,000V/5,750-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,700V-433V														
DUAL500-11-6.1-CC	**500 kVA**, 11,000/6,100V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	6,100V-433V														
DUAL1000-11-5.5-CC	**1000 kVA**, 11,000/5,500V-433V, 3 phase, Cable connected HV and Close-coupled LV type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,500V-433V														
DUAL1000-11-5.75-CC	**1000 kVA**, 11,000V/5,750-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,700V-433V														
DUAL1000-11-6.1-CC	**1000 kVA**, 11,000/6,100V-433V, 3 phase, Cable connected HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	6,100V-433V														

NOTE: Impedance, Resistance and Reactance values shall be supplied to, at least, two decimal places

Dual Ratio 11kV/6kV - UDE type - HV and LV Flanges on the same Transformer face

Northern Powergrid Code	Description	Manufacturer's Reference and Drawing Number	Core Type (state)	Guaranteed Maximum No Load Losses Fe (kW)	Guaranteed Maximum Load Losses Cu (kW)	HV Tap Connection	Voltage Connection Type	Maximum No Load Losses Fe (kW)	Maximum Load Losses Cu (kW)	Tapping Range	Impedance (%)	Positive Sequence Resistance (%)	Zero Sequence Resistance (%)	Zero Sequence Reactance (%)	Free Breathing Or other	Insulating Fluid (Make and Type)	Volume of fluid (Litres)	Total Mass of Transformer (kg)	Dimensions L (mm)	Dimensions W (mm)	Dimensions H (mm)
DUAL500-11-5.5-UDE	**500 kVA**, 11,000/5,500V-433V, 3 phase, Close-coupled HV and Close-coupled LV type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,500V-433V														
DUAL500-11-5.75-UDE	**500 kVA**, 11,000V/5,750-433V, 3 phase, Close-coupled HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,700V-433V														
DUAL500-11-6.1-UDE	**500 kVA**, 11,000/6,100V-433V, 3 phase, Close-coupled HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	6,100V-433V														
DUAL100-11-5.5-UDE	**1000 kVA**, 11,000/5,500V-433V, 3 phase, Close-coupled HV and Close-coupled LV type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,500V-433V														
DUAL1000-11-5.75-UDE	**1000 kVA**, 11,000V/5,750-433V, 3 phase, Close-coupled HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	5,700V-433V														
DUAL1000-11-6.1-UDE	**1000 kVA**, 11,000/6,100V-433V, 3 phase, Close coupled HV and Close-coupled LV Type, Ground Mount Tx					Series	11,000V-433V														
						Parallel	6,100V-433V														

Accessories / Sundries

Northern Powergrid Code	Description	Manufacturer's Reference and Drawing Number	Bushing Style and Standard	Dimensions L (mm)	Dimensions W (mm)	Dimensions H (mm)
HVBOX	HV Cable box Suitable for use with HV transformer flange					
LVBOX	LV Cable box Suitable for use with LV transformer flange					
206424	High flash point, environmentally friendly insulating fluid option (NPS003/019)					

Appendix 4 Addendum to Suppliers Requirements

Losses

Lifetime costs shall be calculated, for every design variant, using the formula below and the latest Northern Powergrid capitalisation figures, which will be provided at the tender stage.

The £/kW loss figures* incorporate utilisation factor and time span.
** Sourced from Northern Powergrid document IMP/001/103 Section 3.4*.

Lifetime Cost = Purchase price + (No load loss kW x No load £/kW) + (Load loss kW x Load loss £/kW)

The tenderer shall supply details of each element of this calculation, in addition to the answer.

The tenderer shall also declare the maximum guaranteed loss figures for each design variant.

Appendix 5 Pre-commission Testing, Routine Inspection and Maintenance Requirements

Tenderers shall provide details of the recommended pre-commission testing and inspection required.

Details of the Test Voltage Levels, duration, pass/fail criteria, etc. shall be provided.

Tenderers shall state any maximum voltage that may be applied or any other limitations that may apply.

Tenderers shall provide information regarding detailed and periodic inspection and maintenance requirements to be undertaken during the lifetime of their product.

Appendix 6 Summary of Test Requirements

IEC 60076 -1 Clause 11.1.2 - Routine tests ($U_m \leq 72.5$ kV)				
IEC 60076-1	**IEC 60076-3**		**ENATS 35-1**	**Northern Powergrid TEST REQUIREMENT**
11.1.2.a		Measurement of winding resistance (11.2)	Routine	**Routine**
11.1.2.b		Measurement of voltage ratio and check of phase displacement (11.3)	Routine	**Routine**
11.1.2.c		Measurement of short-circuit impedance and load loss (11.4)	Routine	**Routine**
11.1.2.d		Measurement of no-load loss and current (11.5)	Routine	**Routine**
11.1.2.e		Dielectric routine tests (60076-3)	Routine	**Routine**
11.1.2.f		Tests on on-load tap changers, where appropriate (11.7)	Not Applicable	**Routine**
11.1.2.h		Tightness tests and pressure tests for tanks for gas-filled transformers (refer to 60076-15).	Not Applicable	**Not Applicable**
11.1.2.i		Check of the ratio and polarity of built-in current transformers. (Where applicable)	Not Applicable	**Routine**
11.1.2.j		Check of core and frame insulation for liquid immersed transformers with core or frame insulation (11.12).	Not Applicable	**Not Applicable**
	7.2.3	Tests to be done in sequence as set out in 60076-3	Requirement	**Requirement**

IEC 60076-1 Clause 11.1.3 - Type tests				
IEC 60076-1	**IEC 60076-3**		**ENATS 35-1**	**Northern Powergrid TEST REQUIREMENT**
11.1.3.a		Temperature-rise test (60076-2)	Type	**Type test**
11.1.3.b		Dielectric type tests (60076-3) - see 11.1.2 above	Type	see 11.1.2 above
11.1.3.c		Determination of sound level (IEC 60076-10)	Type	**Type Test**
11.1.3.d		Measurement of the power taken by the fan and liquid pump motors.	Not Applicable	**Not Required**
11..1.3 e		Measurement of no-load loss and current at 90 % and 110 % of rated voltage.	Type	**Type Test**

IEC 60076-1 Clause 11.1.4 Special tests				
IEC 60076-1	**IEC 60076-3**		**ENATS 35-1**	**Northern Powergrid TEST REQUIREMENT**
11.1.4.a	7.3.1.3	Dielectric special tests (60076-3)	Special	**Type Test**
	Table 1	Lightning Impulse (LIC) (IEC 60076-3 clauses 13 and 14) -	Type	**Type Test**
11.1.4.b		Winding hot-spot temperature-rise measurements.	Not Required	**Not Required**
11.1.4.c		Determination of capacitances windings-to-earth, and between windings.	Not Required	**Not Required**
11.1.4.d		Measurement of dissipation factor (tan δ) of the insulation system capacitances.	Not Required	**Type Test**
11.1.4.e		Determination of transient voltage transfer characteristics. (Annex B. 60076-3)	Not Required	**Not Required**
11.1.4.f		Measurement of zero-sequence impedance(s) on three-phase transformers (11.6)	Not Required	**Type Test**
11.1.4.g		Short-circuit withstand test (60076-5)	Not Required	**Type test**
11.1.4.h		Measurement of dc. insulation resistance	Special	**Type test**
11.1.4.i		Vacuum deflection test on liquid immersed transformers (11.9).	Not Required	**Type test**
11.1.4.j		Pressure deflection test on liquid immersed transformers (11.10).	Not Required	**Type test**
11.1.4.k		Vacuum tightness test on site on liquid immersed transformers (11.11).	Not Required	**Not Required**
11.1.4.l		Measurement of frequency response (Frequency Response Analysis or FRA).	Not Required	**Not Required**
11.1.4.m		Check of external coating (ISO 2178 and ISO 2409).	Not Required	**Type test**
11.1.4.n		Measurement of dissolved gasses in dielectric liquid.	Not Required	**Not Required**
11.1.4.o		Mechanical test or assessment of tank for suitability for transport	Not Required	**Not Required**
11.1.4.p		Determination of weight with transformer arranged for transport.	Not Required	**Type test**

Appendix 7 Technical Information Check List

The following information shall be provided by the supplier for technical review by Northern Powergrid. Additional information shall be provided if requested.

Provided (Y/N)	Requirement
	Full product descriptions and part number/reference (including principle technologies incorporated such as 'amorphous core', etc.)
	Statement of compliance for EU Regulation Tier 2
	Complete set of drawings for each variant
	Appendix 2 – completed self-certification conformance declaration against IEC 60076 and ENA TS 35-1 and NPS/003/011
	Appendix 3 – completed schedule of requirements
	Appendix 4 – completed technical information checklist
	Appendix 5 - Recommended periodical inspection and maintenance requirements
	Appendix 5 - Recommended commissioning test (values and pass/fail criteria)
	Appendix 7 – This table
	Type test and special test listing and/or evidence
	Routine test plan (example)
	Packaging/transport/delivery/handling/storage information