NPS/003/035 – Technical Specification for 11.5/20 kV Step Up Continuous Emergency Rated (CER) Transformers

1. Purpose

This specification details the technical requirements for 11.5/20 kV step up Continuous Emergency Rated (CER) transformers on the Northern Powergrid distribution networks.

This document supersedes the following document, all copies of which shall be removed from circulation.

Reference	Version	Date	Title
n/a			

2. Scope

This specification includes for: 11.5/20 kV step up CER transformers and a requirement for suppliers to provide periodic inspection and maintenance information for the transformers.

It will also be necessary to consider and include any project specific requirements as detailed in Appendix 1, Addendum to Supplier Requirements.

The following appendices form part of this technical specification.

- Appendix 1 - Addendum to Supplier Requirements – Technical Schedules
- Appendix 2a - Self-Certification Declaration of Conformance with ENA TS 35-2 Issue 6 2014
- Appendix 2b - Clause by Clause Conformance with Northern Powergrid NPS/003/035
- Appendix 3 - Pre-commission Testing, Routine Inspection and Maintenance Requirements
- Appendix 4 - Technical Information Check List
- Appendix 5 - Declaration of Manufacturers, Places of Manufacture, Test & Inspection
- Appendix 6 - Specification for Transformer Tank-mounted NDVTs
- Appendix 7 - Specification for Transformer Tank-mounted Auxiliary Transformers

2.1. Table of Contents

3. Technical Requirements

3.1. Compliance with other Specifications and Standards

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.

3.2. Technical Specification

3.2.1. Overall

The equipment shall comply with Energy Networks Association Technical Specification ENATS 35-2: Emergency rated system transformers 66/20.5 kV, 66/11.5 kV and 33/11.5 kV delta/star and star/star connected, however, it should be noted that this specification is for a 11.5/20 kV step up transformer so this is to be assumed throughout this specification as well as the other variations detailed which shall take precedence.

The transformer should be provided to the impedance envelope as detailed in Appendix 1.

The anticipated fault levels for the transformer shall be 350MVA at 20kV and 250MVA at 11kV. These levels will be detailed in appendix 1 when the specification is issued for a particular.

Northern Powergrid have a preference that the core material should be made from High Density High Conductivity (HDHC) copper as opposed to aluminium or other core materials. The proposed core material should be stated in Appendix 2b.

Maximum flux density of the transformer should be 1.9T in normal operation, for operation during overvoltage events and underfrequency events the values quoted in ENATS 35-2 should be used for reference. The equipment shall comply fully with current versions of all other relevant IEC International Standards, British Standard Specifications or equivalent Euro-Norms, and Energy

The equipment must comply with, and allow the end user to comply with, all relevant Health & Safety legislation.

Multicore wiring shall meet the requirements of BS 7671 and ENATS 50-18: Application of Ancillary equipment. Additional clarification for multicore cables is provided in section 3.2.3

3.2.2. Variations to ENA TS 35-2

The following variations or additions are referenced to the clause numbers of issue 6 of ENA TS 35-2:

5.1.1 General

The last sentence of the third paragraph shall be replaced by: ‘ The top oil temperature under these conditions shall not exceed 115°C at an ambient air temperature of 30°C, except where site specific requirements allow an ambient air temperature of 5°C.’

6.4 Specification of tapping in enquiry and order

The tapping range shall generally be one of the four ranges stated below:

a) +/-10% in 16 steps (+/-8 x 1.25%)

b) +5.72% / -17.16% in 16 steps (+4 x 1.43% / -12 x 1.43%)

c) +/-10.5% in 14 steps (+/-7 × 1.5%)

d) +/-% in 5 Steps (+/-2 x 2.5%)

In some circumstances site specific tapping ranges may be required. In this case the required tapping range will be stated in Appendix 1: Addendum to Supplier Requirement -.

6.6 Load loss and temperature rise

Northern Powergrid will establish the value of Iron Loss and Copper Loss (£/kW) based on the transformer specification and network attributes at the point of connection. Losses shall be capitalised using the loss capitalisation values in Appendix 1 of this document. A full description of how Northern Powergrid calculates losses for system transformers can be found in IMP/001/103 – Code of Practice for the Methodology of Assessing Losses.

Lifetime Cost =

Purchase price + ((No load loss kW x No load £/kW) + (Load loss kW x Load loss £/kW)).

Note that the Northern Powergrid loss £/kW figures incorporate utilisation factor and time span.

7.0 Connection and phase displacement symbols for three phase transformers

The vector groups required for this transformer will be outlined in Appendix 1.

Note that the HV neutral only needs to be brought out in the case of units specified to have a neutral displacement voltage transformer. This requirement shall be stated in Appendix 1 of this document.

8.0 Rating Plates

The tapping range shall be expressed in the format:

+/-10% in 16 steps (+/-8 x 1.25%) or +5.72% / -17.16% in 16 steps (+4 x 1.43% / -12 x 1.43%)

Where CTs are fitted internally to the transformer, the CT rating plate markings defined in BS EN 61869-1:2009, Clause 6.13 and BS EN 61869-2:2012, Clause 6.13.202.1 shall be replicated on the transformer rating plate or on a separate rating plate as applicable.

9.3 Liquid Preservation System

Where the oil preservation system is a free breathing system, the breathing pipe for both main and OLTC conservator shall be terminated with a 3/4" male BSP thread to allow the use of a maintenance free cartridge desiccant filter system, such as the Brownell or equivalent. The pipework shall be arranged to allow these cartridges to be changed easily from ground level. These requirements apply to all oil systems that form part of the transformer installation.

11.1 General requirements for routine, type and special tests

The mechanical pressure tests shall be completed before any electrical type or routine tests.

11.1.1 General

Table 2 in ENATS refers to the highest voltage for equipment. These values shall be applied to the appropriate voltage of all windings, not just the highest voltage one.

The Rated lightning impulse (LI) for 11.5kV shall be 95kV (peak) and 28kV (rms) and for 20kV shall be 125kV (peak) and 50kV (rms)

11.1.3 Type tests

For any unit to be connected to the Northern Powergrid distribution network, the full range of type tests shall be performed on the first unit of that type and rating from the given production facility. This requirement may be waived if Northern Powergrid has had sufficient experience of transformers from the production facility and the production facility can supply type test criteria from similar units supplied to other UK Distribution Network Operators or National Grid.

11.14 Determination of sound levels

Sound level measurement shall be carried out under full load conditions. This requirement can only be waived if the condition outlined in IEC 60076-10-1: Clause 9.4 is met and calculations associated with the clause are submitted for approval.

Measurements of sound level shall be carried out for both ONAN and CER ratings. The routine ONAN measurement shall be carried out without the cooler bank and ancillary cooling plants fitted. The type test CER measurement shall be carried out with the cooler bank and ancillary cooling plants running at full capacity i.e. all associated fans and pumps running at full load.

11.15 Frequency Response Analysis (FRA)

FRA shall be carried out on the transformer before leaving the manufacturer's works and repeated again at site following assembly. FRA shall be carried out as stated in IEC 60076-18: Clause 4. The test requirements shall be agreed with Northern Powergrid beforehand.

11.18 Site tests

All tests shall be carried out unless otherwise agreed between the manufacturer and Northern Powergrid.

14.2 Cooling medium

Where transformers contain insulating fluid then this fluid shall comply fully with the current Northern Powergrid Technical Specification NPS/003/019: Technical Specification for Electrical Insulating Fluids for use in Plant & Switchgear. This requirement also applies to any fluid used for first fill and for flushing of the unit.

14.3.1 Separate cooler bank arrangement

Cooler banks shall be transformer tank mounted unless otherwise specified in Appendix 1: Schedule of Requirements.

14.6 Duty under fault conditions

Where Appendix 1 does not require the short circuit test to be carried out, the manufacturer shall demonstrate by calculation, or by providing evidence from a unit of the same design, that the transformer can withstand short circuit forces in accordance with IEC 60076-5. The fault levels expected are listed in 3.2.1 which the transformer will be expected to meet.

15.1 Tanks and covers

The mechanical pressure tests shall be completed before any electrical tests.

15.1.1 Tanks

Working at Height Regulations: The requirements in ENA TS 35-2 shall apply. Details of the provisions incorporated into the design to comply with the Working at Height Regulations must be agreed with Northern Powergrid.

Where work at height is unavoidable and access is to be provided by portable ladder, restraining brackets shall be incorporated into the transformer steelwork to locate and secure the ladder both at the top and at the bottom. Locations are likely to include access to the Buchholz relay, winding temperature indicator thermocouples and connections, and CT terminations.

Ladders used by Northern Powergrid conform to BS 1129 and BS EN131-1 and are manufactured from either wood or glass-fibre. The dimensions of ladders used by Northern Powergrid are listed below.

Rung diameter (mm)	22 (min) 80 (max)
Internal width of section: The minimum distance between sides will not be less than	235mm.

Provision shall be made for both fall restraint and fall prevention systems.

Fall restraint: An anchor point shall be provided at the centre of the lid of the transformer to allow secure connection of a fall restraint lanyard.

Fall Prevention: To facilitate safe working on top of the transformer, the transformer design shall incorporate a series of sockets installed a maximum of 2.1m apart to allow the installation of standard 48.3mm diameter scaffolding tubing of composite, aluminium or steel construction (to suit specific site requirements) to form a post and rail safety system. The sockets shall be designed so that water cannot be retained in the socket.

15.1.4 Earthing Connections

To facilitate earth connections, transformer shall be provided with at least 4 suitable fixings diagonally on opposite corners of the transformer tank. The fixing shall be of a suitable material with a flat type construction comprising of 4 off Φ14mm hole at 50 x 50mm centre to allow copper tape to be connected securely.

For a separate cooler bank design, the same number of earthing facilities shall be provided of the cooler frame.

15.2 Surface Finish

The surface finish colour shall be uniform across the transformer and its auxiliaries and shall be Dark Admiralty Grey to BS381C (RAL 632) .

15.3 Terminals

Cable terminations shall comply with Northern Powergrid technical specifications: NPS/002/015 Technical Specification for 11 kV and 20 kV Joints and Terminations

The impulse level of all cable termination arrangements shall be at least equal to that specified for the transformer.

Where an air cable box or type C bushings (as per BS EN 50180) are used, these shall be housed in an earthed metal enclosure that:

(i) When installed on the transformer provides physical protection, tested to 10 Joules energy impact, in accordance with BS EN 62262, at the most vulnerable points on all exposed faces and on all exposed edges.

(ii) Provides a minimum IP rating of IP21B in accordance with IEC 60529, with the requirement that the unscreened insulation is to be classed as a hazardous part and 300mm clearance shall be maintained from the end of the IP21B test probe.

(iii) Is ventilated so that it does not create a micro-climate that is detrimental to the performance of the components contained in the enclosure and sheds rain water.

(iv) Provides gland plates that are split across each row of gland holes to ease cable installation and termination.

(v) Provides an insulated arrangement to allow connection between the cable sheaths at the terminations inside the enclosure and external circuits, without electrical contact with the enclosure.

Outer cone cable connectors shall not be stacked more than two per bushing. There shall be the same number of connectors on each bushing.

Regardless of connection arrangement; a means of disconnecting the cables from the transformer to allow independent testing of cables and/or transformer shall be provided. If type C bushings are used, then disconnecting links shall be provided in a separate oil filled chamber such that the links can be removed without draining any oil from the main oil system.

Where cable connections are provided then a suitable supporting bracket equipped with NPg approved cable cleats shall be provided for the type and number of cables specified in Appendix 1: Schedule of Requirements.

All AIS bushings shall be fitted with co-ordinating gaps and these shall be set as specified in Table 9 of ENA TS 35-2.

15.3.5 HV neutral

When the HV neutral is brought out to facilitate the connection of a neutral voltage displacement transformer (NDVT) to meet the specific requirements stated in Appendix 1 Clause 7.0, the NDVT shall comply with the technical specification in Appendix 6 of this document.

15.3.6 LV terminations

Cable terminations shall normally be by means of type C bushings unless otherwise stated in Appendix 1.

15.3.7 LV neutral

An accessible isolatable link shall be provided on the neutral point of the LV winding to allow testing.

15.3.8 Auxiliary transformer

The tank mounted auxiliary transformer shall comply with Appendix 7 of this specification and all relevant parts of IEC 60076 and shall be connected as described in ENA TS 35-2.

A tank-mounted, cable connected auxiliary transformer with Type C Bushings will be considered by Northern Powergrid. Any agreed design will need to satisfy Northern Powergrid's protection policy requirements and accessibility requirements.

15.4 On-load tap-changer

Tapchangers shall be equipped with tapchangers designed to perform a minimum of 250,000 operations between maintenance intervals.

The term 'Raise' shall mean raise tap number and raise HV volts; The term 'Lower' shall mean reduce tap number and reduce HV volts.

In some instances an OLTC will not be required and a De-energised Tap Changer will be requested, this will be done via Appendix 1: Addendum to Supplier Requirement. If a DETC is required it is expected that the tapping range will provide a variation of the secondary Voltage of -5%, -2.5%, 0, +2.5% and 5% . This will be confirmed in Appendix 1: Addendum to Supplier Requirement.

15.6.2 Cooling plant

Contactors controlling the power supply to the fans, which are operated from the winding temperature indicator panel in the local substation control room, shall be 110V AC. This supply shall be provided from the marshalling kiosk.

If the transformer cooling system does not have an oil pump and there are four or more cooling fans, then in order to maintain the required level of flexibility, half of the cooling fans shall be controlled by what would have been the oil pump control circuit.

An option shall be provided for temperature related variable speed fan motors to avoid any step increases in noise-level.

15.6.3 Gas-and-oil actuated relay

All valves and relay test facilities shall be padlockable using Northern Powergrid standard padlocks.

The oil actuated relay shall also operate in the event of loss of oil from the system. Relay hydraulic pipework shall be plastic covered copper construction of diameter 8mm and 10mm for drain and test functions respectively with petcock type sampling valves contained within a lockable steel enclosure.

The manufacturer shall demonstrate that the relay can be tested for alarm and trip function via air injection from ground level.

15.6.5 Winding Temperature Indicators (WTI)

Winding temperature indicators should be provided as part of the transformer for installation. This can be provided in either of the ways which are detailed below. The preferred method of winding temperature indication will be detailed in Appendix 1

A winding temperature sensor arrangement shall be provided to monitor the temperature of the LV winding, utilising a platinum resistance thermometer (PT100), located in the top of the transformer and a CT monitoring the LV winding current. The resistance thermometer should be installed in such a way that the unit can be replaced without significant work.

The resistance thermometer shall be wired in accordance with Northern Powergrid drawing Y030S2704.

The output from the resistance thermometer shall be terminated in weatherproof compartment using connectors capable of accepting a screened multi-core cable. Northern Powergrid will supply and install the multicore cable and the winding temperature monitoring relay (Ashridge 852, or equivalent) which will be located in the substation control room.

If it is requested a local WTI and/or OTI (detailed in Appendix 1). This will consist of a capillary return back to a standalone temperature dial. This dial should include the facility for a high temperature alarm and/or contacts to initiate fans to assist the cooling on the transformer if it is required.

15.6.6 Current transformers

Winding temperature indicator (WTI) and line drop compensation (LDC) current transformers shall be installed on the 2V winding within the transformer tank and shall be connected as shown in drawing Y030S2704. Current transformers shall be terminated in the transformer control wiring marshalling cubicle. The table below states the WTI and LDC current transformer ratios.

	TX Size (MVA)	10	15	24	30	40	50
11kV	LV Winding Temperature CT Ratio	500/1	750/1	1200/1	1500/1	2000/1	2500/1
	Line Drop Compensation CT Ratio	500/1	750/1	1200/1	1500/1	2000/1	2500/1
20kV	LV Winding Temperature CT Ratio	-	-	750/1	1000/1	1200/1	-
	Line Drop Compensation CT Ratio	-	-	750/1	1000/1	1200/1	-

All WTI and LDC CTs shall be Class 1, FS5 type.

Any other CTs as specified in Appendix 1 or separately, shall be provided for protection/monitoring schemes. These shall preferably be accommodated within the bushing turret or alternatively supported on the cable below the cable box as appropriate. If slip-over CTs are specified, the transformer manufacture will provide a suitable/robust support structure below the cable box.

Two solid core CTs (15/0.015A and 0.05VA) shall be provided for fan and pump current monitoring. These shall be connected in accordance with Northern Powergrid drawing Y030S2704.

Where CTs are mounted in bushing turrets CT test loops shall be provided in accordance with Figure 2 of ENA TS 35-3.

15.7 Marshalling and Control Box.

In addition to the requirements of ENATS 50-18 and ENATS 09-06 all wiring colours requires to be in line with BS7671. All multicore cables are required to be of the SWA cable type with E1W type glands used throughout.

It is required to use spring loaded terminals (WDU6SL / WDU10SL) throughout the marshalling and control box. Hooked Blade Crimps (HBC) is to be used throughout with individual crimps to be used for individual wires only. In instances where the use of Hooked Blade Crimps are not possible, please use manufacturer's recommended type. Multiple wires used to a single crimp is not acceptable.

All labels provided for all ancillary items should be able to be read from ground level and must be fixed in position using screws and not glued or rivoted. All labels should conform to NPg standard nameplate design to provide label guidance drawing if required.

15.12 Condition monitoring equipment

CER Transformers shall be equipped with the total of three pairs of fibre optic temperature sensors; one active sensor and one spare sensor per phase, to insure against failure in service.

Each pair of sensors shall be located at the winding design predicted hotspot in each phase.

Sensors shall be in accordance with BS EN 61757-1, terminated with ST-type optical connectors and be suitable for use with a Nortech Sentinel II analyser, or similar.

The fibre optic sensor outputs shall be terminated in a tank mounted cabinet that provides sufficient space for a Nortech Sentinel II analyser, or similar, and associated communication and 230V ac cables.

Each fibre optic sensor termination shall be labelled to identify the location of the sensor, including which phase they relate to and whether they are in the HV or LV winding.

The transformer supplier shall provide Northern Powergrid with details, including a drawing, of where the sensors are located within the windings.

The tank mounted cabinet shall be factory equipped with a 230V single phase AC supply, from the auxiliary transformer.

16.1 Drawings

In addition to the drawing items (i) to (ix) of ENATS 35-2, a combined general arrangement and schematic drawing of the oil flow and valve locations and valve functions shall be supplied.

4. References

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

4.1. External Documentation

Reference	Title
BS 1129	Specification for portable timber ladders, steps, trestles and lightweight staging
BS 2562	Cable boxes for transformers and reactors
BS 7671	Requirements for Electrical Installations
BS 7870-8.1	LV and MV polymeric insulated cables for use by distribution and generation utilities. Specification for multicore and multipair cables for installation above and below ground. Single wire armoured and PVC sheathed multicore cable with copper conductors. Section 8.1 Single wire armoured and PVC sheathed multicore cable with copper conductors
BS EN 131-1	Ladders. Terms, types, functional sizes
BS EN 50180	Bushings above 1 kV up to 52 kV and from 250 A to 3,15 kA for liquid filled transformers. General requirements for bushings
BS EN 61757-1	Fibre optic sensors Part 1: Generic specification
BS EN 61869-1	Instrument transformers. General requirements
BS EN 61869-2	Instrument transformers. Additional requirements for current transformers
BS EN 61869-3	Instrument transformers. Additional requirements for inductive voltage transformers
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
ENA TS 09-6	Auxiliary multicore and multipair cables
ENA TS 50-18	Application of Ancillary Electrical Equipment
ENA TS 35-2	Emergency rated system transformers 66/20.5 kV, 66/11.5 kV and 33/11.5 kV delta/star and star/star connected
IEC 60076-1	Power transformers. General
IEC 60076-10	Power transformers - Part 10-1: Determination of sound levels –Application guide
IEC 60076-18	Power transformers - Part 18: Measurement of frequency response.
IEC 60076-3	Power Transformers - Part 3: Insulation levels , dielectric tests and external clearance in air
IEC 60529	Degree of protection provided by enclosures (IP Code)
The Grid Code	The Grid Code (GB)

4.2. Internal Documentation

Reference	Title
IMP/001/103	Code of Practice for the Methodology of Assessing Losses
IMP/001/909	Code of Practice for Distribution System Parameters
IMP/001/913	Code of Practice for the Economic Development of the EHV System
NPS/002/015	Technical Specification for 11kV and 20kV Cable Joints & Terminations
NPS/003/019	Technical Specification for Electrical Insulating Fluids for use in Plant & Switchgear
Y030S2704	Supply point TX FDR/TX Transformer control Ashridge 852 Plus-P (panel mounted) HV and LV winding temperature indicators.
Y213X99312	Tank and covers general arrangement

4.3. Amendments from Previous Version

Reference	Amendments
Nil	

5. Definitions

Term	Definition
Nil	

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	17/04/2023

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 & Reason	
No	Period: 5 Years	Reason: Update will be dictated by contract renewal date or any significant changes in the specification or documents referenced

		Date
Paul McAdoo	Senior Policy and Standards Engineer	21/04/2023

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
Sunil Shrestha	Design and Specification Engineer	25/04/2023
Michael Crowe	Technical Services Manager (North)	20/04/2023
Joseph Helm	Policy and Standards Manager	21/04/2023

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	Head of System Strategy	25/04/2023

Appendix 1 - Addendum to Supplier Requirements

(Project or Site Specific Requirements)

ENA TS 35-2 Issue 6 (2014)	Description		Requirement
4.2	Ambient Temperature for Emergency Rating	°C	
5.1	Rated Power at Emergency Rating	MVA	
	HV Nominal Voltage .	kV	
	LV Nominal Voltage	kV	
6.4	Tapping range		
	a)	+/-10% in 16 steps (+/-8 x 1.25%)	
	b)	+5.72% / -17.16% in 16 steps (+4 x 1.43% / -12 x 1.43%)	
	c)	+/-10% in 14 steps (+/-7 × 1.5%)	
	d)	+5/-5% in 5 steps (DETC)	
6.5	Impedance Envelope		
6.6	Loss Capitalization Values		
	(i) No-load Loss	£/kW	
	(ii) Load Loss at 50% CER rating	£/kW	
	Lifetime Cost = Purchase price + ((No load loss kW x No load £/kW) + (Load loss kW x Load loss £/kW)) *Note that the Northern Powergrid loss £/kW figures incorporate utilisation factor and timespan*		
7.0	Vector Group (Connection Symbol): Include phase displacement numbers and neutral symbols where appropriate		
	For HV wye windings, does the neutral require to be brought out (to allow the connection of neutral displacement transformer)?		
	Vector Links required		
	If yes, alternative vector group		
9.2	Neutral Conductor and Terminal intended to carry load		
9.3	Oil Preservation System		
	If free breathing, Breather Type		
11.1.4	Short Circuit Test required		
11.15	FRA test required at works and on site		

ENA TS 35-2 Issue 6 (2014)	Description	Requirement
11.16	Third Harmonic Test required	
14.3	Cooler Banks:	
	a) Separate	
	b) Tank Mounted	
14.3.1	Separate Cooler Bank required	
	Height Limitation mm	
	Valve & Blanking plates required at alternative oil inlet	
14.4	Anti-Vibration Mountings required	
14.5	Auxiliary Supply Voltage	
	Rating of the Auxiliary Transformer	
15.3.1	Position of Cable Boxes	
15.3.4	HV Terminal Arrangement	
	NVD Capacitor Taps required	
	Capacitance required pF	
	Surge Arresters required	
	Brackets for Surge Arresters required	
	Number and Size of Single Core Cables to be terminated	
15.3.5	HV Neutral Terminal arrangement	
	Size of Single Core Cable to be terminated	
15.3.6	LV Terminal arrangement	
	Number and Size of Single Core Cables to be terminated	
15.3.7	LV Neutral Terminal arrangement	
	Size of Single Core Cable to be terminated	
	LVN Current Transformer(s) required	
	Details of LVN Current Transformer(s)	
15.3.8	Additional Flange required for Auxiliary Transformer	
15.4.1	On Load Tapchanger	
	De-energised Tap Changer	
15.6.5	Winding temperature Indicators (WTI)	
	Required WTI/OTI arrangement (Ashridge or local WTI/OTI)	
	Thermocouple Sensors Type	
	WTI on HV Winding required	
	WTI on LV Winding required - Details:	

ENA TS 35-2 Issue 6 (2014)	Description		Requirement
	Winding Temperature Indicator CT position	HV	
		LV	
		Tertiary	
15.6.6	Additional Current Transformer accommodation required		
	CTs for Voltage Control	Details:	
	CTs for Protection Schemes	Details:	

Appendix 2a - Self-Certification Declaration of Conformance with ENA TS 35-2 Issue 6 2014

Transformers covered by ENA TS 35-2 shall comply with the latest issues of the relevant International and British Standards. ENA TS 35-2 is intended to amplify and/or clarify the requirements of those Standards.

This check sheet identifies the clauses in ENA TS 35-2 and the clauses of IEC 60076-1.

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

Conformance declaration codes	Instructions for completion
N/A = Clause is not applicable or appropriate to the product Cs1 = The product conforms fully with the requirements of this clause Cs2 = The product conforms partially with the requirements of this clause Cs3 = The product does not conform to the requirements of this clause Cs4 = the product does not currently conform with the requirements of this clause, but the manufacturer proposes to modify and test the product in order to comply.	– When Cs1 code is entered no remark is necessary – When any other code is entered the reason for non-conformance shall be entered – Where options are specified, the remark shall identify the option offered by the manufacturer

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
1	Scope			N/A	
2	Normative references			N/A	
3	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		N/A	N/A	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
	drop				
3.8	Temperature rise		N/A	N/A	
3.9	Insulation		N/A	N/A	
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	
4	Service conditions		N/A	N/A	
4.1	General			N/A	
4.2	Normal service conditions			Value of cooling air temp °C for CER	
5	Rating and general requirements				
5.1	Rating				
5.1.1	General			Emergency rated power MVA	
5.1.2	Preferred values of rated power			Graph of CER vs. ambient Graph of ONAN vs. ambient Graph of CMR vs. ambient Maximum CMR MVA	
5.1.3	Minimum power under alternative cooling modes			ONAN rated power MVA	
5.1.4	Loading beyond rated power			N/A	
5.2	Cooling mode			N/A	
5.3	Load rejection on generator			Is the transformer suitable	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
	transformers			for generator transformer load rejection?	
5.4	Rated voltage and frequency			N/A	
5.4.1	Rated voltage			HV rated voltage kV LV rated Voltage kV	
5.4.2	Rated frequency			Rated frequency Hz	
5.4.3	Operation at higher than rated voltage and/or at other than rated frequency		N/A	N/A	
5.5	Provision for unusual service conditions		N/A	N/A	
5.6 5.7 5.7.1 5.7.2 5.7.3 5.7.4	Highest voltage for equipment U_m and dielectric test levels Additional information required for enquiry Transformer classification Winding connection and number of phases Sound level Transport		N/A N/A	N/A N/A	
5.8	Components and materials		N/A	N/A	
6	Requirements for transformers having a tapped winding		N/A	N/A	
6.1	Notation of tapping range		N/A	N/A	
6.2	Tapping voltage, current, etc.		N/A	N/A	
6.3	Tapping power			N/A	
6.4	Specification of tappings			Tapping range offered	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
6.5	Specification of short-circuit impedance			Graph of impedance vs. tap position	
6.6	Load loss and temperature rise			Guaranteed load loss at 50% of CER kW Peak Efficiency Index (PEI) % Regulation (EU) No 548/20: Tier 1 compliance? Tier 2 compliance? If not, give reasons	
7	Connection and phase displacement symbol			Vector group Alternative vector group where links are provided Stabilising winding provided for star-star transformer	
8	Rating plates				
8.1	General		N/A	N/A	
8.2	Information to be given in all cases			N/A	
8.3	Additional information to be given		N/A	N/A	
9 9.1	Safety, environmental and other requirements Safety and environmental requirements		N/A N/A	N/A N/A	
9.2	Dimensioning of neutral connection			Is neutral connection dimensioned for load current?	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
9.3	Liquid preservation system			Description of liquid preservation system	
9.4	d.c. currents in neutral circuits				
9.5	Centre of gravity marking		N/A	N/A	
10	Tolerances		N/A	N/A	
11 11.1 11.1.1 11.1.2	Tests General requirements for routine, type and special tests General Routine tests			N/A N/A Rated lightning impulse voltage (LI) kV peak Guaranteed sound power level at ONAN dB(A)	
11.1.2.1	Routine tests for all transformers			Where are FRA tests to be carried out?	
11.1.2.2	Additional routine tests for transformers with U_m > 72.5 kV	N/A	N/A	N/A	
11.1.3	Type tests			Are type test results from an identical unit available? Guaranteed sound power level at CER dB(A) Power taken by the fan and liquid pump motors kW No-loss loss and current at 90% of rated load kW, A 100% of rated load kW, A 110% of rated load kW, A	
11.1.4	Special tests			Guaranteed and expected	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
				change of impedance after short-circuit test Special tests included in offer	
11.2	Measurement of winding resistance			N/A	
11.3	Measurement of winding ratio and phase displacement			N/A	
11.4	Measurement of short-circuit impedance and load-loss			N/A	
11.5	Measurement of no-load loss and current			Guaranteed no-load loss kW	
11.6	Measurement of zero-phase sequence impedance (ZPSI)			Guaranteed ZPSI Ω/ph	
11.7	Tests on OLTC		N/A	N/A	
11.8	Leak testing with pressure for liquid immersed transformers			N/A	
11.9	Vacuum deflection test			N/A	
11.10	Pressure deflection test for liquid immersed transformers		N/A	N/A	
11.11	Vacuum tightness on site for liquid immersed transformers		N/A	N/A	
11.12	Check of core and frame insulation		N/A	N/A	
11.13	Temperature Rise at Emergency Rating	N/A		N/A	
11.14	Determination of Sound Levels	N/A		N/A	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
11.15	Frequency Response Analysis	N/A		Is frequency response analysis is included in offer?	
11.16	Measurement of the harmonics	N/A		3rd harmonic component %	
11.17	Insulation resistance measurements	N/A		N/A	
11.18	Site tests	N/A		N/A	
12	EMC		N/A	N/A	
13 14 14.1	High frequency switching transients Transformer details No. of phases and frequency	N/A	N/A	N/A N/A	
14.2	Cooling medium	N/A		Cooling medium offered	
14.3	Cooling	N/A		Cooling type at CER	
14.4 14.4.1	Limiting dimensions Separate cooler bank arrangement	N/A		Does the transformer meet requirements of 14.4.1?	
14.4.2	Anti-vibration mountings	N/A		Percentage isolation value and description of AV mountings	
14.5	Auxiliary supply voltage	N/A		Supply voltage for tap-changer and cooler	
14.6	Duty under fault conditions	N/A		Short-circuit capability demonstrated? (supply details & test certificates)	
15	Construction details	N/A		N/A	
15.1	Tanks and covers	N/A		N/A	
15.1.1	Tanks	N/A		Total oil required (including	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
				cooling system). litres Filling medium for transport Overall height when arranged for transport on trailer mm Overall weight when arranged for transport on trailer tonnes Total weight as installed in service including cooler plant, all fittings and oil. tonnes Type of haulage facilities offered	
15.1.2	Covers	N/A		Is offer for bolted or welded cover?	
15.1.3	Gaskets	N/A		Description of gasket material and thickness	
15.1.4	Earthing connections	N/A		N/A	
15.1.5	Sound attenuation enclosures	N/A		Is sound attenuation enclosure offered?	
15.2	Surface finish	N/A		Finish colour offered	
15.3	Terminals	N/A		Are separate disconnecting chambers provided? Position of HV and LV terminals	
15.3.1	Cable boxes	N/A		Position of cable boxes	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
				Oil-filled disconnecting chamber included?	
15.3.2	Outdoor bushings	N/A		N/A	
15.3.3	Plug-in separable connectors	N/A		Type of cone offered	
15.3.4	HV terminals	N/A		Type of terminals offered NVD capacitor taps offered? Surge arresters included? Brackets for surge arresters included? Co-ordinating gaps included?	
15.3.5	HV neutral terminal	N/A		Type of terminal offered Accessible isolatable link offered?	
15.3.6	LV termination	N/A		Type of termination offered Cable disconnecting links included?	
15.3.7	LV neutral termination	N/A		Type of termination offered LV neutral current transformer(s) included? Accessible isolatable link included?	
15.3.8	Earthing/auxiliary transformer	N/A		Earthing/auxiliary transformer type? Is flange and valve included?	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
				Rating HV terminations Other details, if not standard	
15.4	On-load tap-changer	N/A		N/A	
15.4.1	Operating mechanism	N/A		Description of motor protection Is a max/min tap position indicator included?	
15.4.2	Segregation of compartments	N/A		N/A	
15.4.3	Method of operation	N/A		N/A	
15.5	Clearance to exposed conductors	N/A		N/A	
15.6	Fittings	N/A		N/A	
15.6.1	Conservator	N/A		Is low oil level alarm included?	
15.6.2	Cooling plant	N/A		Cooling loss kW Number of pumps Continuous rating of pump motor kW Starting current of pump motor A Number of fans Continuous rating of fan motor shaft kW Starting current of fan motor A	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
				Fan diameter mm Speed of fans rpm Provision for separate cooler bank at either end of the tank?	
15.6.3	Gas-and-oil actuated relay	N/A		N/A	
15.6.4	Pressure relief device	N/A		N/A	
15.6.5	Winding temperature indicators	N/A		Description of provision of winding temperature indication Is a second WTI included?	
15.6.6	Current transformers	N/A		Current transformer accommodation fitted? Second voltage compounding CT fitted?	
15.6.7	Other fittings	N/A		N/A	
15.6.8	Valves	N/A		N/A	
15.7	Marshalling/control box	N/A		Means of condensation protection Description of security	
15.8	Interconnecting cables	N/A		N/A	
15.9	Magnetic circuit	N/A		N/A	
15.10	Core and winding assemblies	N/A		N/A	
15.11	Padlocks	N/A		N/A	
15.12	Condition monitoring equipment	N/A		Condition monitoring	

Clause / Sub-clause	Requirement	Conformance Code IEC 60076-1	Conformance Code ENA TS 35-2	Schedule item	Remarks
				equipment specified? (If so provide details)	
15.13	LV switchgear and controlgear	N/A		N/A	
16	Documentation	N/A		Proposed maintenance schedule	
16.1	Drawings	N/A		Electronic drawing format	
16.2	Assembly, operation and maintenance instructions			Electronic format for instruction manual	

Appendix 2b - Clause by Clause Conformance with Northern Powergrid NPS/003/035

ENA TS 35-2 Clause	Requirement	Conformance Code	Schedule item	Remarks
N/A	Multicore wiring		Multicore wiring shall meet the requirements of BS 7870-8.1 and ENA TS 09-06.	
N/A	Core Material		State the proposed core material of the transformer	
5.1.1	General		Rating ambient temp (30°C)	
5.4.3	Operating frequency limits.		Continuous operation at 47.5Hz and 20 second rating at 47Hz	
6.4	Specification of tappings in enquiry and order		Standard tapping ranges stated	
6.6	Load loss and temperature rise		Loss capitalisation basis as described in IMP/001/103 – Code of Practice for the Methodology of Assessing Losses	
7.0	Connection and phase displacement symbols		Vector groups required for use on the Northern Powergrid networks	
8.0	Rating plates		Format and content of rating plates	
9.3	Liquid Preservation System		Breather pipe thread ¾” BSP	
11.1	General requirements for routine, type and special tests		Mechanical tests before electrical tests.	
11.1.1	General		The Rated lightning impulse (LI) for 11.5kV shall be 95kV (peak) and 28kV (rms)	
11.3	Type tests		Full type tests on first unit of each type from each production facility.	
11.14	Determination of sound levels		CER type test with radiators fitted and all cooling on	

ENA TS 35-2 Clause	Requirement	Conformance Code	Schedule item	Remarks
			Benchmark ONAN type test without radiators fitted Routine ONAN noise measurement without radiators fitted	
11.15	Frequency Response Analysis (FRA)		FRA before leaving the manufacturer's works and repeated at site	
14.2	Cooling medium		Cooling medium to NPS/003/019	
14.3.1	Separate cooler bank arrangement		Cooler banks transformer tank mounted unless otherwise specified	
15.1	Tanks and covers		Mechanical tests to precede electrical tests	
15.1.1	Tanks		Working at height arrangements; retraining brackets for ladders for short time inspection/work and socket system to allow post and rail fall prevention	
15.1.4	Earthing Connections		4 Suitable earth connections on each corner of the transformer tank and the same if a separate cooler bank is required.	
15.2	Surface finish		Dark Admiralty Grey	
15.3	Terminals		Compliance with Northern Powergrid cable termination specifications	
15.3	Terminals		Impulse level of cable termination arrangements at least equal to that specified for transformer	
15.3	Terminals		Earthed metal enclosure for outer cone connectors	
15.3	Terminals		Cable box tested to 10 Joules energy impact	
15.3	Terminals		Cable box min IP rating of IP21B, unscreened insulation to be classed as a hazardous.	

ENA TS 35-2 Clause	Requirement	Conformance Code	Schedule item	Remarks
			300mm clearance maintained from the end of the IP21B test probe	
15.3	Terminals		Cable box ventilated and to shed rain water	
15.3	Terminals		Split gland plates to ease cable installation and termination	
15.3	Terminals		Cable box to allow connection between the cable sheaths at the terminations inside the enclosure and external circuits, without electrical contact with the enclosure	
15.3	Terminals		Outer cone cable connectors shall not be stacked more than two per bushing. There shall be the same number of connectors on each bushing.	
15.3	Terminals		A means of disconnecting the cables from the transformer to allow independent testing of cables and/or transformer shall be provided	
15.3	Terminals		If separable connectors are used, disconnecting links shall be provided in a separate oil filled chamber	
15.3	Terminals		Where cable connections are provided then a suitable supporting bracket equipped with NPg approved cable cleats shall be provided	
15.3	Terminals		AIS bushings fitted with co-ordinating gaps	
15.3	HV Terminals		Provision of cable cleats on supporting bracket	
15.3	HV Terminals		Cable disconnecting links where inner cone connectors are used	
15.3.5	HV neutral		Where HV neutral brought out to connect a NDVT, the NVDT shall comply with the technical specification in Appendix 6	

ENA TS 35-2 Clause	Requirement	Conformance Code	Schedule item	Remarks
15.3.6	LV Terminations		Cable terminations below 33kV shall be by means of an air filled cable box unless otherwise stated	
15.3.7	LV neutral		Accessible isolatable link shall be provided on the neutral point of the LV winding to allow testing	
15.3.8	Auxiliary transformer		Provision of tank mounted auxiliary transformer to comply with Appendix 7	
15.3.8	Auxiliary transformer		Tank mounted, cable connected option for connection of auxiliary transformer subject to protection and accessibility requirements	
15.4	On-load tap-changer		Tapchangers equipped with tapchangers designed to perform a minimum of 250,000 operations between each maintenance.	
15.4	On load tap-changer		'Raise' and 'Lower' tap change terminology	
15.6.2	Cooling plant		Control supply 110V	
15.6.2	Cooling plant		Staged operation of fans where no oil pumps	
15.6.2	Cooling plant		Option for variable speed fan motors	
15.6.3	Gas and oil actuated relay		Sampling and testing points lockable	
15.6.3	Gas and oil actuated relay		Relay operation for loss of oil	
15.6.3	Gas and oil actuated relay		Relay hydraulic pipework of stainless steel or plastic covered copper construction of diameter 6mm and 10mm for drain and test functions respectively with petcock type sampling valves with colour-coded fittings	
15.6.5	Winding Temperature Indicators		Winding temperature utilised using a platinum resistance thermometer (PT100), and a CT monitoring the LV winding current.	

ENA TS 35-2 Clause	Requirement	Conformance Code	Schedule item	Remarks
15.6.5	Winding Temperature Indicators		PT100 should be installed in such a way that the unit can be replaced without significant work	
15.6.5	Winding Temperature Indicators		Temperature sensor criteria	
15.6.5	Winding Temperature Indicators		Wired as per Y030S2704	
15.6.6	Current Transformers		WTI and LDC current transformers installed on the L2 LV winding within the transformer tank connected as shown in drawing Y030S2704	
15.6.6	Current Transformers		WTI and LDC current transformer ratios as specified	
15.6.6	Current Transformers		CTs for protection schemes In bushing turret or cable box	
15.6.6	Current Transformers		Where CTs are mounted in bushing turrets CT test loops shall be provided in accordance with Figure 2 of ENA TS 35-3.	
15.6.6	Current Transformers		Two solid core CTs (15/0.015A and 0.05VA) for fan and pump current monitoring wired as per Y030S6701	
15.7	Marshalling and Control Box		All SWA multicore cables use E1W type glands	
15.7	Marshalling and Control Box		Spring loaded terminals and hooked blade crimps used throughout the marshalling kiosk.	
15.7	Marshalling and Control Box		All labels readable from ground level and fixed to the tank using screws.	
15.12	Condition monitoring equipment		Also equipped with three pairs of fibre optic temperature sensors; each pair of sensors shall be located at the winding design predicted hotspot in each phase	
15.12	Condition monitoring equipment		Fibre optic temperature sensor criteria as specified	

ENA TS 35-2 Clause	Requirement	Conformance Code	Schedule item	Remarks
16.1	Additional drawings		In addition to the drawing items (i) to (ix) of ENATS 35-2, a combined general arrangement and schematic drawing of the oil flow and valve locations and valve functions shall be supplied	

Appendix 3 - Pre-commission Testing, Routine Inspection and Maintenance Requirements

Suppliers shall provide details of the recommended pre-commission testing and inspection required. They shall also provide information regarding periodic inspection and maintenance requirements to be undertaken during the lifetime of their product.
Detailed inspection and maintenance instructions shall also be provided.

Appendix 4 - 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.

Requirement	Provided (Y/N)
Full product descriptions and part number/reference	
Complete set of drawings for each variant	
Appendix 2a - Completed self-certification conformance declaration against ENA TS 35-2	
Appendix 2b- Completed self-certification conformance declaration against NPS/003/035	
Appendix 3 - Pre-commissioning testing/inspection requirements	
Appendix 3 - Recommended periodical inspection and maintenance requirements	
Appendix 5 – Declaration of Manufacturers, Places of Manufacture, Test & Inspection	
Appendix 6 - Completed self-certification conformance declaration against requirements for transformer tank-mounted NDVT	
Appendix 7 - Completed self-certification conformance declaration against requirements for transformer tank-mounted auxiliary transformer	
Copies of ISO 9001 certificate of accreditation for main manufacturing facility(s)	
Declaration of technical non-conformances against tech spec clauses	
Type test evidence (summary list and copies of all type test evidence)	
Routine test plan (example)	
Details of Insulating fluid type proposed and confirmation of compliance with NPS/003/019	
COSHH sheets	
UK DNO references/previous customers that have been supplied with these products.	
Copy of pricing schedule template populated with product codes/description	
Work at Heights provision – details of system(s) offered	

Appendix 5 - Declaration of Manufacturers, Places of Manufacture, Test & Inspection

Item	Manufacturer's Drawing Number and/or Type Designation	Manufacturer	Place of Manufacture	Place of Testing & Inspection
Transformers complete On-load tap-change equipment HV Bushings LV Bushings Neutral Bushings Radiators Pipework Expansion Devices Oil valves Oil Pumps Oil Pump Motors Fans Fan Motors Dehydrating Breather Gas and Oil Actuated Relay(s) Outdoor Marshalling/Control Box Temperature Indicating Devices Auxiliary Transformer Material for Anti-Vibration Mounting				
Any subsequent deviation from this declaration schedule shall be notified in writing as soon as possible for the Purchaser's approval.				

Appendix 6 - Specification for Transformer Tank Mounted NDVTs

Specification for Transformer Tank Mounted Neutral Displacement Voltage Transformers (NDVTs)

A6-1 Overview

A6.1.1 ENA TS 35-2 allows for flange mounting of an outdoor voltage transformer for neutral displacement protection. The NDVT primary winding shall be connected between the transformer winding star point and earth.

A6.1.2 The NDVT shall be designed, constructed and tested in accordance with BS EN 61869-3 Instrument transformers - Additional requirements for inductive voltage transformers.

A6-2. Electrical Performance Requirements

A6.2.1	Highest voltage for equipment (Um)	36 or 72kV
A6.2.2	Secondary winding output voltage	63.5 V
A6.2.3	Minimum rating	50 VA
A6.2.4	Accuracy Class	6P
A6.2.5	Basic Insulation	Oil Immersed

A6-3. General Construction and Fittings

A6.3.1: The oil in the NDVT shall be separated from the oil in the main transformer by means of an internal barrier that shall be pressure tested in accordance with section 10.11 of ENA TS 35-2, in both directions.

A6.3.2: The NDVT shall incorporate the following features:

- Oil preservation system in accordance with Sub clause 9.3 of section 3.3.2 of NPS/003/035
- Tank and covers in accordance with Sub clause 15.1 of section 3.3.2 of NPS/003/035 and within the constraints Northern Powergrid drawing number Y213X99312.
- Oil level indicator
- Rating and diagram plate
- Terminal box with removable, padlockable cover. This terminal box shall contain links as required to comply with the winding arrangements specified in section A6-4 below. These links shall be clearly identified.
- A cable gland for a 2 core multicore cable

A6-4. Winding Arrangements

A6.4.1: The earthing of the primary winding shall be independent of, and segregated from, the earthing of the secondary winding.

A6.4.2: Primary winding terminal “N”: The primary winding neutral point shall be provided with an accessible isolatable link to allow testing. The primary winding neutral link shall be enclosed in a lidded, dry metal box. A drawing of the proposed arrangement shall be provided for approval.

A6.4.3: The primary winding terminal "A" shall be connected to a HV bushing by a flexible lead. This bushing shall connect the NDVT to the main transformer HV neutral and shall be within the main transformer oil system.
It shall be possible to easily disconnect this flexible lead to the bushing for the purpose of testing the main transformer.

A6.4.4: The secondary winding terminals "a" and "n" shall be connected to links (typically GEC RS20 type) or equivalent in the terminal box. The "n" terminal winding neutral point shall be provided with an accessible isolatable link to allow testing. The secondary winding neutral link shall be enclosed in a lidded, dry metal box. A drawing of the proposed arrangement shall be provided for approval.

A6-5. NDVT Conformance Declaration

The conformance declaration table below shall be completed for each unit.

Clause	Description	Confirmation/Comment/Description
A6.1.1	NDVT primary winding	
A6.1.2	Compliance with BS EN 61869-3 Instrument transformers - Additional requirements for inductive voltage transformers.	
A6.2.1	Highest voltage for equipment (Um)	
A6.2.2	Secondary winding output voltage	
A6.2.3	Burden rating	
A6.2.4	Accuracy class	
A6.2.5	Basic insulation type	
A6.3.1	Barrier pressure test	
A6.3.2	Oil preservation system in accordance with section 9.3 of NPS/003/035	
	Tank and covers in accordance with section 15.1 of NPS/003/035 and within the constraints of drawing number Y213X99312	
	Oil level indicator	
	Rating and diagram plate	
	Terminal box with removable, padlockable cover.	
	This terminal box links.	
	Cable gland for a 2 core multicore cable	
A6.4.1	Independent, segregated primary and secondary earthing	
A6.4.2	Primary winding terminal "N"	
A6.4.3	Primary winding terminal "A"	
A6.4.4	Secondary winding terminals "a" and "n"	

Appendix 7 - Specification for Transformer Tank Mounted Auxiliary Transformers

A7.1 Overview

ENA TS 35-2 allows for flange mounting of an outdoor auxiliary transformer. The auxiliary transformer shall be designed, constructed and tested in accordance with ENA TS 35-1 - Distribution transformers, except where varied by this specification.

A7.2. Electrical Performance Requirements

A7.2.1: Input voltage for equipment (Um)	to match the main transformer secondary voltage.
A7.2.2: Output voltage	415V at no load.
A7.2.3: Vector Group	Dyn11
A7.2.4: Rating	50kVA
A7.2.5: Tappings	Not required
A7.2.6: Impedance Voltage (at 75ºC)	4.5% of rated power

A7.3. Mounting Arrangements

A7.3.1: The flange facing and mounting arrangement need not comply with the flange facings specified in ENA TS 35-2, or in ENA TS 35-1, but shall optimise the interface between the main unit and the auxiliary transformer.

A7.3.2: Mounting Arrangements: The auxiliary transformer shall be rigidly supported by the flange mounting arrangement. Additional bracings shall be provided between the auxiliary and main transformer if necessary to ensure adequate and rigid support.

A7.4. LV Terminal Arrangements

A7.4.1: An LV fuseboard shall be mounted on the auxiliary transformer and the LV terminals of the auxiliary transformer shall be connected to this LV fuseboard. The means of connection shall minimise any risk from failure of this connection(s).

A7.4.2: The LV fuseboard shall conform fully to Form 4 Type 2 requirements of BS EN 60439-1, Low-voltage switchgear and controlgear assemblies – Type-tested and partially type-tested assemblies. All terminals and exposed live metalwork shall be shrouded.

A7.4.3: The LV fuseboard shall be designed and constructed to be suitable for outdoor use. The fuseboard, its components (excluding insulating parts) and its mountings shall not require maintenance for a period of at least 30 years in a polluted / coastal environment according to EN ISO 12944-2 Category C4.

A7.4.4: The fuseboard housing shall have a padlockable access door/non-bolted cover; suitable for use with a padlock hasp of 3-6mm diameter.

A7.4.5: The auxiliary transformer LV phase connections shall be terminated, in the LV fuseboard, onto three 100A fuse units that shall be in accordance with Type 3 of BS 7657 (1993); each of which shall be fused with a 60A fuse that shall be in accordance with Type II b of BS1361 (1971).

A7.4.7: The auxiliary transformer LV fuses shall be ergonomically accessible from ground level and be mounted not less than 900mm and not more than 1600mm above ground level.

A7.4.8: The auxiliary transformer LV neutral connections shall be terminated onto an arrangement with two independently removable, bolted links inside the LV fuseboard:

(a) the outgoing side of one link shall be connected to a designated earth connection point on the auxiliary transformer
(b) the outgoing side of one link shall be connected to the outgoing LV cable

A7.4.9: The underside of the LV fuseboard housing shall have a suitably positioned 20mm diameter cable access hole, equipped with a compression gland for a 4-core armoured 25mm2 cable that will be used to connect to the outgoing sides of the LV fuses.

A7.4.10: The LV fuseboard shall be equipped with all necessary connections/lugs to allow termination of a 4-core armoured 25mm2 cable used to connect to the outgoing sides of the LV fuses

As an alternative to the LV fuseboard; an arrangement incorporating an LV fuse switch will be considered, provided that all the above specified performance and operational requirements are met.

A7.5. Earthing Terminal Arrangement

A7.5.1: An earthing connection shall be provided on the exterior of the auxiliary transformer. This connection shall be designed to accept neutral/earth connection(s) from the bolted link in the LV fuseboard described above.

A7-6. Auxiliary Transformer Conformance Declaration

The conformance declaration table below shall be completed for each unit.

Clause	Description	Confirmation/Comment/Description
A7.1.1	Conformance with ENA TS 35-1	
A7.2.1	Input voltage	
A7.2.2	Output voltage	
A7.2.3	Vector group	
A7.2.4	Rating	
A7.2.5	Tappings	
A7.2.6	Impedance voltage (at 75ºC)	
A7.3.1	Flange facing	
A7.3.2	Mounting arrangements	
A7.4.1	LV terminals & connection	
A7.4.2	Form 4 Type 2 requirements of BS EN 60439-1	
A7.4.3	Withstand 30 years in EN ISO 12944-2 Category C4	
A7.4.4	Padlockable door/cover	
A7.4.5	LV fuse & link arrangements	
A7.4.6	Neutral connection	
A7.4.7	Cable hole & gland	
A7.5.1	Earth terminal arrangement	