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NPS/001/012 - Technical Specification for Cast Resin Pole Mounted Auxiliary Supply Transformers

1. Purpose

The purpose of this document is to provide a technical specification for the supply of cast resin pole mounted auxiliary power supply transformers for use on the 11, 20 and 33kV distribution networks of Northern Powergrid.

This document supersedes the following documents, all copies of which should be destroyed;

Document Reference	Document Title	Version	Published Date
NPS/001/012	Technical Specification for Cast Resin Pole Mounted Auxiliary Supply Transformers	4.0	March 2018

2. Scope

This specification details the technical requirements of pole mounted overhead line 11, 20 or 33kV Cast Resin Voltage Transformers (CRVT's) which are utilised primarily to provide 250VA, 230V AC auxiliary power supplies to pole mounted auto reclose circuit breakers and designed for connection across two phases of an overhead line.

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3. Technical Requirements

3.1. Compliance with Standards

The equipment shall be designed to generally comply with the requirements of BS EN 61869-1:2009 'Instrument transformers' and 61869-3: 2011 'Additional requirements for inductive voltage transformers'.

3.2. Equipment Ratings

3.2.1. Equipment Ratings

The CRVT's are required for use on a three phase, 50Hz, distribution system with nominal system voltages of 11, 20 or 33kV.

In the case of the 11kV and 20kV system voltages, it is preferable that manufacturers offer a dual voltage unit suitable for installation onto either 11kV or 20kV nominal system voltages; i.e. designed to comply with the 20kV electrical parameters but where selection of the appropriate LV terminals will provide a secondary output voltage of 230V without any variation in the available power rating.

The following table provides minimum requirements for the CRVT's

Nominal System Voltage	11kV	20kV	33kV
Highest voltage for equipment Um (r.m.s) (kV)	12	24	36
Secondary Output Voltage (V)	230	230	230
Primary Winding - Rated Power Frequency withstand voltage (BSEN 61869-1 Table 2) (kV)	28	50	70
Secondary Winding - Rated Power Frequency short duration withstand voltage (kV)	3kV for 1 Min	3kV for 1 Min	3kV for 1 Min
* Lightning impulse withstand voltage (BIL) (kV)	125	170	200
Power rating (VA)	250	250	250
Voltage Factor	1.2 Um continuously	1.2 Um continuously	1.2 Um continuously
Min Nominal specific creepage distance (BS EN 61869-1 (Table 6 - level 3) (mm)	275	500	825
**Min separation between primary winding terminals & Primary terminals to earth (mm)	200	280	280

* The standard lightning impulse withstand voltage levels have been increased to match the rating of the adjacent Pole Mounted Reclosers bushings.

** Based on BS EN 60076-3 Table 4

3.2.2. System Earthing

The equipment shall be suitable for use on a distribution system with the neutral Solidly Earthed, Impedance Earthed or via a Resonant Earthing system.

3.2.3. EMC Regulations

All units shall satisfy the Electromagnetic Compatibility (EMC) requirements detailed in BSEN 61869-1 clause 6.11 and its sub clauses.

3.3. Normal Service Conditions

The CRVT's shall be capable of operation within the following service conditions:

- Ambient temperature range of -25°C to +40°C where the average value of the ambient air temperature, measured over a period of 24h, does not exceed 35°C.

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- b) The wind pressure will not exceed d 700 Pa (corresponding to 34 m/s wind speed).
- c) Account should be taken of the any detrimental effects created by condensation and precipitation.
- d) The maximum installation altitude will not be required to exceed 1000m.
- e) Ice coating does not exceed 20mm

3.4. General Mounting Requirements

The CRVT's shall be securely mounted onto aluminium mounting plates suitable for attachment on to wood poles in a vertical orientation.

Following service experience, proposed arrangements shall be designed whereby the CRVT base plate is secured onto an additional or second mounting plate specifically designed for mounting onto the curved surface of a wood pole with sufficient self-strength so as not to transfer any distortions onto the CRVT base plate and thus risk compromising any waterproof seal created between the base of the CRVT and its base plate. To limit the volume of rain water and or creosote running directly onto the CRVT mounting plate from the pole, the mounting plate shall be provided with a 30mm standoff from the pole supported by strengthening rings at the fixing points.

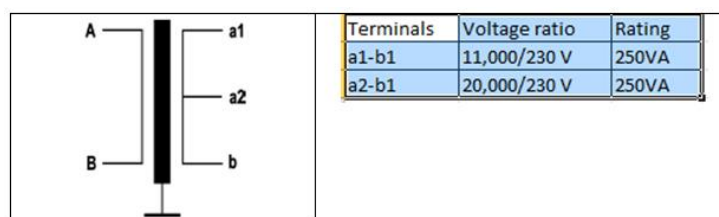
To simplify on site mounting of the CRVT it shall be designed for mounting using two Keyhole slot arrangements sized to accommodate the M20 fixing bolts. Additionally the mounting plate shall be provided with a two x M18 HV earth bonding holes located in each lower corner of the mounting bracket.

Note - is it assumed that the metallic core inside the CRVT will be effectively bonded to the rear base plate and hence the pole mounting plate by the various metallic interfaces, providing an effective HV earth connection point.

3.5. LV Terminal Enclosure

The design of the CRVT shall incorporate a waterproof LV terminal enclosure with a removable lid. All fixings used to secure the lid to the enclosure shall be captivated.

LV terminals marked a1, and b or (a1, a2 and b for dual voltage CRVT units designed to operate on either 11 or 20kV primary input voltages) located within the enclosure, shall be suitable for terminating 2.5mm PVC insulated conductor(s). The unit shall incorporate a suitable removable link between an internal earth terminal and the b or negative terminal of the LV winding.



Example of LV Terminal markings and connections on a single ratio unit

The earth terminal located within the enclosure shall be effectively bonded to the transformer mounting plate.

The enclosure shall incorporate a cable entry point suitable for the termination of an M20 cable gland.

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3.5.1. Degrees of Protection by Enclosures

The minimum degree of protection against the ingress of water into the low-voltage enclosure shall be to IEC 60529 class IP44.

3.6. Rating and Connection Plates

Transformers shall be fitted with a rating plate as detailed in BSEN 61869-3 clause 6.13.302

A connection plate is required to show the winding connections and shall be generally in accordance with Fig 302 of BSEN 61869-3. The connection plate may be part of the rating plate.

Rating and connection plates shall be of durable and non-corrodible material and shall be securely fixed to the mounting plate

3.7. Terminal Markings

Terminals shall be clearly marked and identified in accordance with BS EN 61869-3 clause 6.13.

3.8. Losses

CRVT's shall provide the following typical losses:

Iron Loss	36 (W)
Copper	20 (W)

These loss values detailed above shall be taken as the guaranteed losses and the tolerances shall be measured in accordance with IEC 60076.

3.9. Short Circuit Withstand Capability

In accordance with clause 6.301 of BSEN 61869-3 voltage transformers shall be designed and constructed to withstand without damage when energised at rated voltage, the mechanical and thermal effects of an external short-circuit for the duration of 1 s.

3.10. Testing

3.10.1. Routine Tests

Routine tests shall be carried out on all transformers as specified in BS EN 61869-3 and shall include:-

Description of Test	Sub clause of BSEN 61869-1 unless quoted otherwise
Power frequency voltage withstand tests on primary terminals	7.3.1 of BSEN 61869-3
Partial discharge measurement	7.3.2
Power frequency voltage withstand tests between sections	7.3.3
Power frequency voltage withstand on secondary terminals	7.3.4
Test for accuracy	7.3.5
Verification of markings	7.3.6

Notes

Partial discharge test procedure shall be carried out as described in clause 7.3.2 & 7.3.2.2 using procedure 'B' with maximum allowable discharge levels limited to 20_{pC} in accordance with Table 3 of BS EN 61869-1.

3.10.2. Type Tests

Type tests shall be carried out on the first unit of any design. The tests shall be carried out in accordance with BS EN 61869-1 or BS EN 61869-3 as specified.

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Description of Test	Sub clause of BSEN 61869-1 unless quoted otherwise
Temperature-rise test	7.2.2 of BSEN 61869-3 method (a)
Short Circuit withstand Capability Test	7.2.301 of BSEN 61869-3
Impulse voltage test on primary terminals	7.2.3 of BSEN 61869-3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Verification of degree of protection by enclosures	7.2.7

3.10.3. Additional – Special Tests

3.10.3.1. Thermal Cycling in Water Bath Test (Northern Powergrid Test)

The thermal cycling of equipment in a water bath has shown to be a searching test for CRVT's to determine if they are susceptible to moisture ingress.

6 x CRVT's shall be placed in a shallow bath for a period of 3 weeks with the bases submerged in water containing a fluorescein dye to a depth that at least covers the interfaces between the cast resin moulding and the baseplate.

In order to thermally cycle the CRVT's, 6 units shall be connected up in a test chamber and supplied with full HV system volts with a 200VA resistive load bank applied to the secondary terminals of each unit, i.e. 80% of their rated capacity.

The test cycle shall apply a load for 8 hours during the working day to warm up the units followed by the units cooling down back to ambient temperature during the night. The units shall be cycled for a minimum of 15 cycles i.e. 3 weeks of Monday – Friday. At the start of each new cycle, insulation resistance test measurements shall be taken between the LV & HV windings and earth.

Prior to the start of the test cycle, three of the CRVT's shall be mounted and secured on a vertical pole to replicate the normal service position and thus stress the interfaces between the CRVT and its mounting plates.

Upon completion of the testing the results shall be collated into a report complete with photographic evidence of the dissected section. The criteria for pass/fail have been detailed below.

Upon completion of the test cycling process each unit shall be cut into a series of vertical sections using an electric band saw. Each section shall be inspected for any evidence of moisture ingress within the units at interfaces between the internal core and the resin. The choice of sectioning positions on the CRVT shall include a section taken through the captive nuts of the LV terminals and its enclosure and through the threaded inserts installed into the base of the CRVT.

The fluorescein dye is sensitive to ultra violet light, and when the units are dissected following completion of the test it can be easily determined where the moisture has penetrated. In some cases it takes several days for the absorbed moisture to become evident on the cut surfaces of the CRVT as such the surfaces shall be re-inspected three days after the initial dissection process.

Pass / failure criteria

- The insulation resistance readings taken between the HV and LV windings and between the HV & LV windings and earth when compared against readings taken at both the start and end of the cycling process shall not vary by more than 5%.
- There shall be no significant insulation voids found in the dissected sections.
- There shall be no evidence of moisture transfer into the CRVT core area on the sectioned units.

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3.10.3.2. Internal Arc Test

This is a special test which is required to be carried out in accordance with BSEN 61869-1 clause 7.4.6 to confirm that the unit being offered has been designed and constructed to withstand without damage; the mechanical and thermal effects of an external short-circuit across the LV terminals. In the event that a CRVT of a similar design is already qualified to this test, the manufacturer is permitted to provide test documentation demonstrating the ability of the non-qualified unit to withstand an internal arc without performing any additional tests.

3.11. Flux Density

The maximum flux density in any magnetic part shall not exceed 1.9 Tesla with 1.1 Um applied at a frequency of 47 Hz. Transformers shall not over flux under these conditions.

3.12. Over Voltage Protection

No over voltage protection other than the increased BIL requirements for these transformers is required.

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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 (ENATS) current at the time of supply.

4.1. External Documentation

Reference	Title
BSEN 60076-3:2013+A1:2018	Power Transformers Part 3 - Insulation Levels, Dielectric tests and external clearances in air
BSEN 60529:1992+A2:2013	Degrees of protection provided by enclosures (IP code).
BSEN 61869-1:2009	Instrument transformers. General Requirements for Instrument Transformers
BSEN 61869-3:2011	Inductive Voltage Transformers

4.2. Internal Documentation

Reference	Title
N/A	

4.3. Amendments from Previous Version

Reference	Description
3 Technical Requirements	11/20kV dual ration transformer requirement added
Appendix 1 Schedule of Requirements	New dual ratio 11/20kV transformer added

5. Definitions

Term	Definition
CRVT	Cast Resin Voltage Transformer

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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	23/04/2020

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 contact 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
Steven Salkeld	Policy and Standards Engineer	02/06/2020

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
Ged Hammel	Senior Policy and Standards Engineer	01/06/2020
Mick Emsley	Policy and Standards Manager	02/06/2020

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Greg Farrell	Head of System Engineering	11/06/2020

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Appendix 1 – Schedule of requirements

NPg Commodity Code	Description
193270	Dual ratio 11/20kV / 230V, 250VA Cast Resin Auxiliary Voltage Transformer*
193271	33kV / 230V, 250VA Cast Resin Auxiliary Voltage Transformer

***Note**

The items below show commodity codes for the discrete 11 and 20kV VT's, however the NPg preferred requirement will be to replace these units with a new single 11/20kV dual ratio unit. (Commodity codes 193270).

193265	11kV / 230V, 250VA Cast Resin Auxiliary Voltage Transformer (for information only - obsolete)
193268	20kV / 230V, 250VA Cast Resin Auxiliary Voltage Transformer (for information only - obsolete)

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Appendix 2 - Addendum to Supplier Requirements

Protection and Packaging

The equipment shall be suitably packaged and protected with each unit marked with the following information:

- (i) Manufacturers name.
- (ii) Manufacturer's product type and unique unit serial number.
- (iii) Description of item.
- (iv) Date of supply.
- (v) Company order number.
- (vi) Purchasing Companies Stock Catalogue Number.
- (vii) Weight of each unit.

Unpacking and Lifting

The supplier shall provide any required information for unpacking and lifting safely, including details of any special lifting and positioning devices which are necessary

Test Certificates

All cast resin pole mounted auxiliary transformers shall be supplied complete with a copy of the routine tests carried out on the equipment during its manufacture. The test cards shall be enclosed in a waterproof document holder and be attached to the unit.

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Appendix 3 - Self Certification Conformance Declaration

Cast Resin Pole Mounted Auxiliary Transformers covered by BS EN 61869-1 and BS EN 61869-3 shall comply with this technical specification and the latest issues of the relevant international and British Standards.

This check sheet identifies the clauses in BS EN 61869-1 and BS EN 61869-3 relevant to Cast Resin Pole Mounted Auxiliary Transformers for use on the distribution networks of Northern Powergrid

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

Conformance declaration codes

N/A = Clause is not applicable/ appropriate to the product

Cs1 = The product conforms fully with the requirements of this clause

Cs2 = The product conforms partially with the requirements of this clause

Cs3 = The product does not conform to the requirements of this clause

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 conform.

Instructions for completion

- When Cs1 code is entered the supplier shall provide evidence of conformance
- When any other code is entered the reason and supporting evidence for non-Conformance shall be entered
- Prefix each remark with the relevant 'BS EN' or 'ENATS' as appropriate

Manufacturer:

Product Reference:

Name:

Signature:

Date:

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Cast Resin Pole Mounted Auxiliary Transformers

BS EN 61869 - 1 or 3 (as specified)				
Clause/Sub-clause	Requirement	Conformance Code	Evidence Reference	Remarks/Comments
4	Normal and Special Service Conditions			
5	Ratings			
6	Design requirements			
7.2.2 7.2.301 7.2.3 7.2.4 7.3.5 7.2.7	Type Tests Temperature Rise test (BS EN 61869-3) Method (a) Short Circuit withstand Capability Test (BSEN 61869-3) Impulse Voltage test on Primary terminals Wet Test for outdoor type transformers Electromagnetic Compatibility Tests Verification of degree of protection by enclosures			
7.3.1 7.3.2 7.3.3 7.3.4 7.3.5 7.3.6	Routine Tests Power Frequency Voltage Withstand Tests on primary terminals Partial Discharge Measurement Power Frequency voltage withstand tests between sections Power Frequency voltage withstand tests on secondary terminals Test for accuracy Verification of markings Special Tests			
7.4.6	Internal Arc Test			

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Clause/Sub-clause	Requirement	Conformance Code	Evidence Reference	Remarks
3.2.1	Equipment Ratings			
3.4	General Mounting Requirements			
3.5	LV Terminal Enclosure			
3.6	Rating & Connection Plates			
3.7	Terminal markings			
3.8	Losses			
3.9	Short Circuit Withstand Capability			
3.10.3.1	Special Tests – Thermal Cycling in Water Bath Test (Northern Powergrid Test)			
3.10.3.1	Visual inspection.			

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Appendix 4 - 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 both periodic and detailed inspection and maintenance requirements to be undertaken during the lifetime of their product.

Product Disposal

The need to minimize the impact of CRVT's during all phases of their life on the natural environment is now recognized. The manufacturer shall provide specific information regarding any environmental management aspects of the CRVT during service life, dismantling of the equipment and disposal.

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Appendix 5 - 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	
Appendix 2 – completed addendum to suppliers requirements, protection and packaging, unpacking and lifting	
Appendix 3 – completed self-certification conformance declaration	
Appendix 4 - Pre-commissioning testing/inspection requirements, including details on the end of life disposal of these units	
Complete set of drawings for each variant	
Weight of each unit	
Type and special test evidence	
Product Quality Plan	