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# NPS/003/040 – Technical Specification for 132kV Combined Metering Transformers

## 1. Purpose

This purpose of this document is to specify the technical requirements for 132kV Combined Metering Transformers for use on the distribution networks of Northern Powergrid.

## 2. Scope

This specification details the requirements for 132kV Combined Metering Transformers for use in open terminal substations on the distribution networks of Northern Powergrid for the metering of circuits with a rated capacity exceeding 100MVA for settlement purposes as required by Code of Practice One of the Balancing and Settlement Code. This specification shall be used in conjunction with any project specific requirements detailed in Appendix 5, Addendum to Supplier Requirements.

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### 3. Technical Requirements

The Combined Metering Transformers detailed in this specification are designed for use in outdoor open terminal 132kV substations for the metering of circuits with a rated capacity exceeding 100MVA for settlement purposes. Combined Metering Transformers are generally mounted on aluminium or steel support structures and connected to adjacent equipment using copper or aluminium busbars.

Combined Metering Transformers shall meet the requirements of BS EN 61869 parts 1, 2, 3 and 4 and shall meet the requirements of Code of Practice One of the Balancing and Settlement Code. Where the standards provide alternative options, Northern Powergrid's specific requirements stated within this specification shall also be met.

Code of Practice One of the Balancing and Settlement Code requires the transformers to be of wound construction and meets the 'Tests for Accuracy' stated in BS EN 61869-4.

Appendix 1 contains a schedule of electrical requirements for Combined Metering Transformers.

Appendix 2 contains a declaration of performance to be completed by the manufacturer.

Appendix 3 contains pre-commissioning testing/inspection requirements, including details on end of life disposal to be completed by the manufacturer.

Appendix 4 contains a self-certification declaration which must be completed by the manufacturer for each product offered.

Appendix 5 contains an Addendum to Supplier Requirements which lists any project specific requirements.

Appendix 6 contains a technical information check list.

#### 3.1. General Design Requirements

The Combined Metering Transformer will preferably have been assessed by the Energy Networks Association (ENA) and awarded an ENA Notice of Conformance. Products that do not have an ENA Notice of Conformance that are judged to be technically acceptable shall undergo an equivalent assessment process undertaken by Northern Powergrid.

##### 3.1.1. Voltage Transformer

The voltage transformer (VT) shall be designed in accordance with BS EN 61869 parts 1 and 3 and 4, the requirements listed below and in Appendix 1 of this document in addition to Electromagnetic Compatibility EMC regulations.

The VT shall be of wire wound (inductive) construction to BS EN 61869-1 and BS EN 61869-3.

The provision of arcing horns is required.

Project specific requirements are stated in Appendix 5. The technical specification of the VT must be confirmed using the table in Appendix 2.

##### 3.1.2. Current Transformers

The current transformers (CTs) shall be designed in accordance with BS EN 61869 parts 1 and 2 and 4, the requirements listed below and in Appendix 1 of this document in addition to the Electromagnetic Compatibility Regulations.

The CT support/housing may be of porcelain or composite construction, however if a porcelain construction is offered, it shall meet the requirements stated in Section 3.1.3.3.

CTs shall have a thermal rating not less than the rated primary current of the associated switchgear.

The technical specification of the CT must be confirmed using the table in Appendix 2.

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### 3.1.3. Common Components

#### 3.1.3.1. External Insulation

The Combined Metering Transformer support/housing insulation shall comply with the requirements of BS 3297-2 designation "C" and Appendix 1 of this specification.

The external insulation shall be manufactured from either grey silicon rubber hollow core composite material that has been tested in accordance with IEC 62231, IEC 61462 and IEC 62217 or from brown porcelain cylindrical material tested in accordance with IEC 60168 and has been proven to satisfy clause 3.1.3.3 of this specification.

#### 3.1.3.2. Additional Requirements for External Insulation of Composite Construction

Hollow composite external insulation typically consists of an insulating tube manufactured from high strength glass fibre reinforced plastic bearing the mechanical load which is protected by an elastomeric housing.

Variations in the composition of this material can adversely affect its long term performance to provide the following very important properties including UV resistance, tracking resistance and hydrophobicity. To ensure longevity of the insulation, key components of the material shall exceed the minimum requirements in the table below:

Material Composition	Minimum % per weight
Base Rubber consisting of approx. 37% Silicone Polymer (Polydimethylsiloxane) (PDMS) and 10% Silica	47 %
Filler (ATH Aluminium tri hydrate and fumed silica)	52 %
Additional parts (pigments, crosslinkers)	1%

Where manufacturer's materials differ from this composition, they shall provide supporting evidence to demonstrate the long term performance of their product formulation.

Minimum acceptable values for the physical properties of the insulation material offered are stated in the table below:

Property	Minimum Value
Density	1.5g/cm
Passing Voltage Level of IEC 60587	4.5kV
Flammability Class of IEC 60695-11-10 of 3mm specimen	VO
Tensile Strength (Din 53504-S1)	6 N/mm <sup>2</sup>
Break Elongation (Din 53504-S1)	300%
UV resistance @ 300nm the energy of UV wavelength that equates to a molecular energy breakdown level of 398 kJ/mole *	445 kJ/Mole

\* assumed wavelength of UV light (sun) 290 – 350nm

All silicon rubber insulators shall be manufactured using the HTV (high temperature vulcanising) method and shall ensure that the interface between the housing and the core is chemically bonded.

Flash or mould lines shall not exceed 1mm in height.

All glass fibre re-enforced plastic tubes shall be covered by an even concentric layer of silicon rubber that has a minimum insulation thickness of 3mm over the tube.

#### 3.1.3.3. Internal Arc Fault Protection Requirements

Where a porcelain insulating material is used in the construction of the Combined Metering Transformer, manufacturers shall provide type test evidence confirming that the proposed design has satisfied the internal arc fault protection requirements of BS EN 61869-1 clause 6.9.

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Combined Metering Transformers can be considered to be compliant with this clause of the specification where test evidence is provided confirming a class 2 rating when the unit was subjected to an internal arc fault current r.m.s. value of at least 31.5kA with fault duration of 0.2s.

#### **3.1.3.4. Short Circuit Withstand Capability**

The Combined Metering Transformer 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 3 seconds.

#### **3.1.3.5. End Fittings**

The end fittings transfer the mechanical load to the hollow tube core. The interface between the end fittings and the hollow tube shall be sealed by an elastomer with permanent elasticity. The sealing bond shall adhere to the surface of the metal fittings as well as the housing. Sealing by compression only is not acceptable.

#### **3.1.3.6. Secondary Wiring Enclosure**

The Combined Metering Transformer shall include a secondary terminal enclosure with a removable lid. This enclosure shall as a minimum comply with IP65 in accordance with IEC 60529 and the terminals shall be insulated for a 2kV withstand test. The enclosure shall be so placed as to permit access with the equipment energised. External to the secondary terminal enclosure, a bolted type earth link shall be provided for the VT primary winding. For further information regarding Earthing please see BS EN 50522.

All wiring and connection arrangements shall be as detailed in ENA TS 50-19 and ENA Engineering recommendation S15 Part 3.

The installation shall meet the requirements of ENA TS 50-18 Design and Application of Ancillary Electrical Equipment.

All fixings used to secure the lid to the enclosure shall be captive.

The enclosure shall provide a means of terminating of an armoured protection cable using a metric size M20 brass CW20 3 part cable gland.

#### **3.1.3.7. Design Life**

Combined Metering Transformers shall be designed to provide a minimum operating life of 40 years in normal outdoor service conditions as defined by BS EN 61869-1 clause 4.2.5.

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## 4. References

### 4.1. External Documentation

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.

Reference	Title
2006 No. 3418	Electromagnetic compatibility: The Electromagnetic Compatibility Regulations 2006
Balancing and Settlement Code	Code of Practice One, Code of Practice for the Metering of Circuits with a Rated Capacity Exceeding 100MVA for Settlement Purposes
BS 3297-2	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
BS EN 50522	Earthing of power installations exceeding 1 kV a.c.
BS EN 61869-1	Instrument Transformers – Part 1: General Requirements
BS EN 61869-2	Instrument Transformers – Part 2: Current Transformers
BS EN 61869-3	Instrument Transformers – Part 3: Inductive Voltage Transformers
BS EN 61869-4	Instrument Transformers – Part 4: Combined Transformers
Din 53504	Determination of tensile strength at break, tensile stress at yield, elongation at break and stress values of rubber in a tensile test
ENA ER S15 Part 3	(1967) Basic diagrams for voltage and current transformer secondary
ENA TS 50-18	Energy Network Association Technical Specification - Design and application of ancillary electrical equipment
ENA TS 50-19	Energy Network Association Technical Specification - Standard Numbering For Small Wiring (for switchgear and transformers together with their associated relay panels)
IEC 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000V
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60587	Electrical Insulating materials used under severe ambient conditions – test methods for evaluating resistance to tracking and erosion
IEC 60695-11-10	Flammability classification
IEC 61462	Composite hollow insulators – pressurised and un-pressurised insulators for use in electrical equipment with rated voltage greater than 1000V – Definitions, test methods, acceptance criteria and design recommendations
IEC 62217	Polymeric Insulators for indoor and outdoor use with a nominal voltage >1000V – general definitions, test methods and acceptance criteria
IEC 62231	Composite Station Post insulators for substations with a.c. voltages >1000V up to 245kV – general definitions, test methods and acceptance criteria

### 4.2. Internal Documentation

Reference	Title
n/a	n/a

### 4.3. Amendments from Previous Version

Reference	Description
Whole Document	Doc approved by email Paul Black 30/10/2023 Doc republished to grid and externally - LB 07/02/2024

## 5. Definitions

Term	Definition
n/a	

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## 6. Authority for issue

### 6.1. CDS Assurance

I sign to confirm that this document has been assured for issue on to the CDS system

		<b>Date</b>
Liz Beat	Governance Administrator	07/02/2024

### 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	<b>Period:</b> 5 Years	<b>Reason:</b> Update will be dictated by contract renewal date or any significant changes in the specification or documents referenced.
<b>Should this document be displayed on the Northern Powergrid external website?</b>		Yes
		<b>Date</b>
Joseph Helm	Senior Policy and Standards Engineer	06/12/16

### 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.

		<b>Date</b>
Hong Soo Goh	Protection Engineer	07/12/16

### 6.4. Authorisation

Authorisation is granted for publication of this document

		<b>Date</b>
Paul Black	Head of System Engineering	30/10/2023

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## Appendix 1: Electrical Ratings 132kV Combined Metering Transformers

General	BS EN 61869	Requirement
Highest Voltage for Equipment $U_m$ (rms)	Part 1, Table 2	145kV
Rated Frequency	Part 1, clause 5.4	50Hz
Service Conditions	Part 1, clause 4.2.5	Outdoor
Ambient air temperature range	Part 1, clause 4.2.1	-25/40 °C
Altitude	Part 1, clause 4.2.2	Does not exceed 1000m
System earthing	Part 1, clause 4.4	Solidly earthed neutral
Limits of Temperature Rise to be limited by the lowest class of insulation either of the winding or the surrounding medium – manufactures to specify	Part 1, clause 6.4	In accordance with Table 3 or manufactures data for specific material types
Rated short time thermal current	Part 1, clause 5.3	Minimum 31.5kA for 3 seconds but not less than that of associated HV Switchgear
Partial Discharge – permissible levels (PD levels in Pc)	Part 1, clause 5.3.3.1 Table 3	Values associated with earthed neutral systems
Insulation requirements for secondary windings	Part 1, clause 5.3.4	3kV (r.m.s) for 60 seconds

Current Transformer	BS EN 61869	Requirement
Rated Secondary Voltage		
Number of secondary outputs		Two CTs are required for metering main and check
Factor of Safety	Part 2, clause 5.6.201.6	FS5
Rated primary current	Part 2, clause 5.201	Equivalent to the rating of the CT primary winding as specified in Appendix 5
Rated continuous thermal current	Part 2, clause 5.203	2000A or as specified in Appendix 5
Rated short-time thermal current ( $I_{th}$ )	Part 2, clause 5.204.1	Minimum of 31.5kA for 3 seconds, but in any case rated current to be no less than that of associated switchgear.
Rated Dynamic current ( $I_{dyn}$ )	Part 2, clause 5.204.2	2.5 times rated short-time thermal current

Voltage Transformer	BS EN 61869	Requirement
Design	Part 3	Inductive (wound) construction
Number of secondary windings		2



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Insulation	BS EN 61869	Requirement
Rated insulation levels of the primary winding – (Wet 1min PF Withstand)	Part 1, Table 2	275 kV
Rated insulation levels of the primary winding - (peak) – Dry Impulse	Part 1, Table 2	650 kV
Length of Post Insulators (min)		1500 +/- 2.5mm
Minimum phase to earth creepage distance		3350mm
External Insulation Requirements: Pollution level – creepage distance	Part 1, clause 6.6.1 Table 6	Level 3: 25mm/kV (Heavy )
Mechanical Requirement for support	Part 1, clause 6.7	Load class II: Static withstand load 3kN
Insulator Base Fixing Arrangement		Where the base of the support insulator is mounted directly onto support steelwork the PCD shall be as stated. (Where an additional under base is used, the fixings shall be agreed with the purchaser)
Pitch circle diameter (mm)	127	
Bolt Hole (Tapped Hole)	4 x M16	
Metal Fittings (internal/external)	External	

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## Appendix 2: Declaration of technical performance

### MANUFACTURERS TYPE REFERENCE:

#### General

Rating	Unit of measure	Specification of Product Offered
Nominal System Voltage	V	
Highest Voltage for Equipment $U_m$ (rms)	V	
Rated Frequency	Hz	
Design – Combined metering transformers?		Yes/no
Service Conditions – Suitable for outdoor use?		Yes/no
Ambient air temperature range	°C	
System earthing – Solidly Earthed Neutral?		Yes/no
Limits of Temperature Rise – and or Insulation class	°C	
Rated short time thermal current	kA	
Partial Discharge – permissible levels	%	
Insulation requirements for secondary windings	kV	

#### Voltage Transformers

Rating	Unit of measure	Specification of Product Offered
Design – Wound (inductive) voltage transformer?		Yes/no
Rated Secondary Voltage	V	
Ratio		
Burden	VA	
Number of secondary outputs		
Class of Secondary Output		

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## Current Transformers

Rating	Unit of measure	Specification of Product Offered
Rated Secondary Voltage	V	
Ratio		
Burden	VA	
Number of secondary outputs		
Class of Secondary Output		
Factor of Safety		
Rated primary current	A	
Rated secondary current	A	
Rated continuous thermal current	A	
Rated short-time thermal current ( $I_{th}$ )	kA	
Rated Dynamic current ( $I_{dyn}$ )	kA	
Limits of Temperature Rise		
Partial Discharge – permissible levels	%	
Insulation voltage withstand for secondary windings	kV	

## Insulation

Rating	Unit of measure	Specification of Product Offered
Rated insulation levels of the primary winding – (Wet 1min PF Withstand)	kV	
Rated insulation levels of the primary winding - (peak) – Dry Impulse	kV	
Length of Post Insulators	mm	
Minimum phase to earth creepage distance	mm	
External Insulation Requirements: Pollution level – creepage distance	mm/kV	
Mechanical Requirement for CT – Static withstand load	kN	
Insulator Base Fixing Arrangement  Pitch circle diameter (mm) Bolt Hole (Tapped Hole) Metal Fittings (internal/external)		

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### **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 and details of how the product should be disposed of when it is taken out of service. Typical information shall be as detailed in Annex B of BS EN 61869 Part 1.

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## Appendix 4: Self Certification Conformance Declaration

Combined Metering Transformers shall comply with the latest issues of the relevant national and international standards.

This check sheet identifies the clauses of BS EN 61869-1, BS EN 61869-2, BS EN 61869-3, BS EN 61869-4, IEC 61462 and IEC 62217 relevant to 132kV Combined Metering Transformers for use on the Northern Powergrid distribution network.

The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes. A separate sheet shall be provided for each product being offered.

### 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 no remark is necessary
- When any other code is entered the reason for non-conformance shall be entered
- Prefix each remark with the relevant 'BS EN' 'IEC' or 'ENATS' as appropriate.

<b>Manufacturer:</b>	
<b>Product Reference:</b>	
<b>Name:</b>	
<b>Signature:</b>	
<b>Date:</b>	

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BS EN 61869-2 Part 2: Additional requirements for current transformers – Type test requirements			
Clause/Sub-clause	Requirement	Conformance Code	Remarks and or type test report numbers
7.2.2	Temperature-rise test		
7.2.3	Impulse voltage withstand test on primary terminals		
7.2.4	Wet test for outdoor type transformers		
7.2.5	Electromagnetic Compatibility tests		
7.2.6	Tests for accuracy		
7.2.7	Verification of the degree of protection by enclosures		
7.2.8	Enclosure tightness test at ambient temperature		
7.2.9	Pressure test for the enclosure		
7.2.201	Short-time current tests		

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BS EN 61869-2 Part 2: Additional requirements for current transformers – Routine tests			
Clause/Sub-clause	Requirement	Conformance Code	Remarks and or type test report numbers
7.3.1	Power-frequency voltage withstand tests on primary terminals		
7.3.2	Partial discharge measurement		
7.3.3	Power-frequency voltage withstand tests between sections		
7.3.4	Power-frequency voltage withstand tests on secondary terminals		
7.3.5	Tests for accuracy		
7.3.6	Verification of markings		
7.3.7	Enclosure tightness test at ambient temperature		
7.3.8	Pressure test for the enclosure		
7.3.201	Determination of the secondary winding resistance		
7.3.202	Determination of the secondary loop time constant		
7.3.203	Test for rated knee point e.m.f. and exciting current at rated knee point e.m.f.		
7.3.204	Inter-turn overvoltage test		

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BS EN 61869-2 Part 2: Additional requirements for current transformers – Special Test (where the external insulation is provided using porcelain)			
Clause/Sub-clause	Requirement	Conformance Code	Remarks and or type test report numbers
7.4.6	Internal arc fault test (to be provided where units are manufactured using porcelain insulation)		

BS EN 61869 Part 3: Additional requirements for inductive voltage transformers – Type test requirements			
Clause/Sub-clause	Requirement	Conformance Code	Remarks and or type test report numbers
7.2.2	Temperature-rise test		
7.2.3	Impulse voltage test on primary terminals		
7.2.4	Wet test for outdoor type transformers		
7.2.5	Electromagnetic Compatibility tests		
7.2.6	Test for accuracy		
7.2.7	Verification of the degree of protection by enclosures		
7.2.8	Enclosure tightness test at ambient temperature		
7.2.9	Pressure test for the enclosure		
7.2.301	Short-circuit withstand capability test		



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BS EN 61869 Part 3: Additional requirements for inductive voltage transformers – Routine tests			
Clause/Sub-clause	Requirement	Conformance Code	Remarks and or type test report numbers
7.3.1	Power-frequency voltage withstand tests on primary terminals		
7.3.2	Partial discharge measurement		
7.3.3	Power-frequency voltage withstand tests between sections		
7.3.4	Power-frequency voltage withstand tests on secondary terminals		
7.3.5	Test for accuracy		
7.3.6	Verification of markings		
7.3.7	Enclosure tightness test at ambient temperature		
7.3.8	Pressure test for the enclosure		

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IEC 61462 – Type tests			IEC 62217			Remarks
Clause / Sub-clause	Requirement	Conformance Code	Clause / Sub-clause	Requirement	Conformance Code	
7.2	Tests on interfaces and connections of end fittings		9.2	Tests on interfaces and connections of end fittings		
7.2.2	Reference dry power frequency test		9.2.3	Reference dry power frequency test		
7.2.3	Thermal Mechanical pre-stressing test		9.2.4	Product specific pre-stressing		
7.2.4	Water Immersion pre-stressing test		9.2.5	Water immersion pre-stressing		
7.2.5	Verification test		9.2.6	Verification test		
7.2.5.1	Visual Examination		9.2.6.1	Visual Examination		
7.2.5.2	Steep Front Impulse Test		9.2.6.2	Steep Front Impulse Test		
7.2.5.3	Dry Power Frequency Voltage Test		9.2.6.3	Dry Power Frequency Voltage Test		
7.3	Tests on shed and housing material		9.3	Tests on shed and housing material		
7.3.1	Hardness Test		9.3.1	Hardness Test		
7.3.2	Accelerated weathering test		9.3.2	Accelerated weathering test		
7.3.3	Tracking and erosion test		9.3.3	Tracking and erosion test		
			9.3.3.1	1000 hour salt fog test		
7.3.4	Flammability Test		9.3.4	Flammability Test		

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7.4	Tests on the tube material		9.4	Tests on the core material		
7.4.1	Dye penetration test		9.4.1	Dye penetration test		
7.4.2	Water diffusion test		9.4.2	Water diffusion test		
			Annex A	Wheel test		
			Annex B	5000H - Test at Multiple stresses		

IEC 61462 – Sample tests			IEC 62217			
Clause / Sub-clause	Requirement	Conformance Code	Clause / Sub-clause	Requirement	Conformance Code	Remarks
9.3.1	Verification of dimensions					
9.4	Mechanical tests					
9.5	Galvanising Test					
9.6	Check of the interface between end fittings and the housing					

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IEC 61462 – Routine tests			IEC 62217			Remarks
Clause / Sub-clause	Requirement	Conformance Code	Clause / Sub-clause	Requirement	Conformance Code	
10.2	Visual examination					
10.4	Routine mechanical test					
10.5	Routine tightness test					
11.0	Documentation					

<b>Document Reference:-</b>		NPS/003/040	<b>Document Type:-</b>		Code of Practice			
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## Appendix 5: Addendum to supplier requirements

Project-specific installation and protection requirements will be provided by Northern Powergrid's Primary Engineering Projects section for inclusion in this appendix.

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## Appendix 6: 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, including a complete set of drawings for each variant	
Appendix 2 – Completed declaration of technical performance	
Appendix 3 - Pre-commissioning testing/inspection requirements, including details on end of life disposal	
Appendix 4 – Completed self-certification conformance declaration	
Appendix 5 – Addendum to suppliers requirements – site specific project requirements	
Type test evidence	
Routine test plan (example)	
Type test evidence confirming clause 3.1.4 has been satisfied for porcelain insulator bushings	