NPS/002/021 – Technical Specification for 33kV Power Cables

1. Purpose

The purpose of this document is to detail the requirements of Northern Powergrid (the Company) in relation to 33kV power cables for use on the Company's distribution network.

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

Document Reference	Document Title	Version	Published Date
NPS/002/021	Technical Specification for 33kV Power Cables	6.0	January 2023

2. Scope

This specification details the requirements for 33kV power cables for use on the company's distribution networks.

It will also be necessary to consider and include any project specific requirements as detailed in Appendix 3: Addendum to Supplier Requirements. Additionally, suppliers shall provide details of any periodic inspection and maintenance information requirements in Appendix 4: Pre-commission Testing, Routine Inspection and Maintenance Requirements.

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 (ENATS) current at the time of supply.

The following appendices form part of this technical specification:

- Appendix 1 - Cables Type / Sizes
- Appendix 2 - Self Certification Conformance Declaration
- Appendix 3 - Addendum to Supplier Requirements
- Appendix 4 - Pre-commission Testing, Routine Inspection and Maintenance Requirements
- Appendix 5 - Logistical Requirements
- Appendix 6 - Technical Information Check List

2.1. Table of Contents

3. Technical Requirements

3.1. Conditions of Installation

Cables specified in this document shall be installed in accordance with the Company's policy NSP/002 – Policy for the Installation of Distribution Power Cables. Cables specified in this document will be pulled or laid into open trenches, pulled into ducts or installed in air. Cables may also be installed directly by trenchless installation techniques. During storage and after installation cables can be expected to be subjected to the full range of climatic conditions encountered in the UK. Cable may be surrounded by ground water for most of their operating lives. Where cable is installed in ducts, flooding of ducts can occur resulting in permanently wet sections along the cable route. Cables installed above ground will be supported by means of cleats designed to meet the fault rating of the cable, either vertically or horizontally and may be exposed to direct sunlight for significant periods. Cables may be installed up wood poles in contact with the pole and therefore in contact with a pole preservation medium such as creosote.

Accessories (joints or terminations) may be cold applied or require the application of heat.

3.2. Conditions of Operation

Power cables purchased in accordance with this specification are required to operate under conditions stipulated in:

- IMP/001/913 - Code of Practise for the Economic Development of the EHV System, and,
- IMP/001/909 – Code of Practice for Distribution System Parameters.

The following are general conditions of operation and represent the minimum requirements for 33kV power cables:

- Nominal system voltages: 33kV.
- All cables and associated equipment for use on the system shall be rated at a minimum of 36kV.
- Nominal system frequency: 50Hz.
- The system operates with the neutral point earthed either directly or through a resistance or reactance at one or more points.
- Fault rating:
    - Suitable for 3 ph symmetrical short circuit currents of 20kA for 2 seconds, and,
    - Phase to earth fault currents of 3kA for 2 seconds (note: at 33kV phase to earth currents are less than 3 ph currents) where the system has been designed with an earth fault factor of 1.73.

3.3. 33kV Power Cables

33kV distribution cables of single core extruded insulation design shall be both single core and in "triplex" configurations.

33kV power cables required to be supplied against this specification shall comply with the latest issues of the relevant ENATS, British and International Standards specified. These are:

- BS EN 60228 - Conductors in Insulated cables,
- BS 7870: 4.10 - LV and MV Polymeric insulated cables for use by distribution and generation utilities,
- ENATS 09 – 17 - Single core cable for use in substations having extruded insulation and rated voltages of 6350/11000 volt and 19000/33000 volt,

- BS EN 60811-1-3 - Insulating and sheathing materials of electric and optical cables — Common test methods

Further reference can be found in Appendix 2 – Self Certification Conformance Declaration.

3.3.1. Conductors

Conductors shall be compacted stranded copper or aluminium in accordance with BS EN 60228. Aluminium conductors shall be longitudinally water blocked. The range of conductor cross sections and materials required is as detailed in Appendix 1.

Both copper and aluminium conductor constructions shall be compatible with use of mechanical connectors. The manufacturer shall declare as to whether water blocking materials within the conductor should be removed or left in-situ when installing mechanical connectors.

3.3.2. Insulation and Screens

The conductor screen, insulation and insulation screen shall be applied as a continuous single pass triple extrusion free of factory repairs. The cross-linking process shall be completely “Dry Cured” and no water will be used during this process. The vulcanisation tube shall be filled with either dry nitrogen or with oil that is compatible with the insulation and screen materials.

For XLPE (type DIX 3) insulation, the shrinkage, when measured in accordance with BS EN 60811-1-3, Clause 10, for 1 h at (130 ±2) °C, shall not exceed 4%. For designs with XLPE insulation, the insulation screen shall be of the "fully bonded" type.

The thickness of the semi conducting screens shall be as specified in the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply.

The nominal insulation thickness shall comply to BS 7870 – 4.10 Table 1.

3.3.3. Metallic Screen and Moisture Blocking

All cables shall have minimum 35mm² copper wire screens and meet the fault rating requirements as detailed in section 3.2. There shall also be a copper equalizing tape or wire installed.

Moisture blocking tape shall be provided under and over the copper wires to provide longitudinal moisture blocking. Moisture content of moisture blocking tape will be less than 50,000 ppm.

Cables shall pass the moisture penetration test outlined in. BS 7870-4.10 Clause 7.8.3.

3.3.4. Oversheath

The oversheath shall consist of an extruded layer of black MDPE complying with the requirements of BS 7870 part 4.10. Maximum permissible shrinkage shall be3% to BS 7870-4.10. The compound shall have a density within the range quoted in ENATS 09-17.

3.3.5. Internal and External Cable Marking

Over sheath embossing and printing for 33kV power cables shall be in accordance with BS 7870 part 4.10, clause 4.5.

Each delivery length of cable shall be allocated a unique reference or batch number. This unique number and shall be embossed or printed on the cable near to the metre mark. This unique reference number will be used to identify all materials used within the manufacturing process offering full product traceability. This number shall appear on the factory test sheet covering the cable length and shall be clearly marked on the drum on which the length is delivered and shall be referred to on all invoices and advice notes.

Cables laid up in "triplex" formation shall have L1, L2, and L3 marked externally by embossing or indenting, and brown, black or grey marker tapes applied internally either below the PE sheath or between copper screen wires and water swellable tapes. These marker tapes shall not compromise the integrity of the water swellable tapes.

All external markings must be clearly visible.

3.3.6. Long Term Ageing

Cable designs offered must have successfully undergone CIGRE long term ageing tests in accordance with amendment 3, clause 5.4.15 to CENELEC HD 605. See also section 3.3 and clause 4.5.

4. References

The cables shall comply with the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of tendering, except where varied by this standard. In respect the following documents are particularly relevant.

4.1. External Documentation

Reference	Title
BS 7870: 4.10 (A1 2016)	LV and MV Polymeric insulated cables for use by distribution and generation utilities
BS EN 60228	Conductors in Insulated cables
CENELEC HD 605	Electrical Cables – Additional test methods
ENATS 09 - 17	Single core cable for use in substations having extruded insulation and rated voltages of 6350/11000 volt and 19000/33000 volt

The supplier shall provide with the tender full technical details of the equipment offered and shall indicate any divergence from these standards or specifications.

4.2. Internal Documentation

Reference	Title
IMP/001/909	Code of Practice for Distribution System Parameters
IMP/001/913	Code of Practice for the Economic Development of the EHV System
NSP/002	Policy for the Installation of Distribution Power Cables

4.3. Amendments from Previous Version

Reference	Title
Document version	Change from version 6.0 January 2023 to version 7.0 October 2024
3.3.2 – Insulation and Screens	Reference changed from 2% to 4% in line with BS 7870-4.10 7.3
3.3.1. – Conductors & Appendix 2	Required declaration of compatibility of waterblocking materials with mechanical connectors and removal/retain declaration.
3.3.3 – Metallic Screens and Moisture Blocking	Remove reference to ‘Radial’ and change IEC-6080:11 to BS 7870-4.10 clause 7.8.3
3.3.4 - Oversheath	Change max permissible shrinkage from 2% to 3% inline with BS 7870-4.10
3.3.5 – Internal and External Cable Marking	Remove requirement for “Northern Powergrid” embossed onto oversheath and amend positioning of marker tapes
4.1 – External Documentation	Removed BS 6234 & IEC 60840
Appendix 2 – Self Certification Conformance Declaration	Amended to reflect changes made in specification

5. Definitions

Term	Definition
The Company	Northern Powergrid
PE	Polyethylene
MDPE	Medium Density Polyethylene
XLPE	Cross Linked Polyethylene

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
Eve Fawcett	Governance Administrator	04/11/2024

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	Period: 5	Reason: To align with Tender Release
Should this document be displayed on the Northern Powergrid external website?		Yes

		Date
Paul Hanrahan	Engineer – Asset Management	04/11/2024

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
Steve Salkeld	Policy & Standards Engineer	04/11/2024
Aaron Chung	Policy & Standards Manager	05/11/2024

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	Head of System Engineering	27/11/2024

Appendix 1 – Cable Types Utilised

The following list of cables types aligns with the requirements of IMP/001/913 - Code of Practice for the Economic Development of the EHV System.

Cable Type	Commodity Code
33kV Single Core	
300mm^2 Circular Stranded Copper Conductor*	018442
400mm^2 Circular Stranded Copper Conductor	018457
500mm^2 Circular Stranded Copper Conductor*	018523
630mm^2 Circular Stranded Copper Conductor*	018531
800mm^2 Circular Stranded Copper Conductor*	108951
500mm^2 Circular Stranded Aluminium Conductor	108952
630mm^2 Circular Stranded Aluminium Conductor	108953
800mm^2 Circular Stranded Aluminium Conductor	108954
33kV Triplex Formation	
300mm^2 Circular Stranded Copper Conductor	018448
400mm^2 Circular Stranded Copper Conductor	108955

* These 33kV cable types presented in the above table align with the standard design requirements of IMP/001/913 - Code of Practice for the Economic Development of the EHV System.

Further cable types presented in the above table form part of the company Assessed Product Database as they may be required as a result of individual scheme designs.

Appendix 2 – Self Certification Conformance Declaration

33kV power cables required to be supplied against this specification shall comply with the latest issues of the relevant ENATS, British and International Standards specified. The following tables are intended to amplify and/or clarify the requirements of elements of these Standards but do not preclude meeting all requirements of the standards.

The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes, where appropriate indicating if tests are type or routine tests.

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 reference to 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' 'IEC' or 'ENATS' as appropriate.
- Provide technical data sheets and associated drawings for each product.

Manufacturer / Supplier:

Manufacturer / Supplier Product Reference:

Northern Powergrid Product Reference (Commodity Code):

Details of the Cable Type (Voltage, Conductor Type and Size):

Name:

Signature:

Date:

NOTE: One sheet shall be completed for each type of cable offered.

NPS/002/021 – Technical Specification for 33kV Power Cables				
	Clause / Requirements	**Conformance Code**	**Evidence Reference**	**Remarks / Comments**
Technical Data	• Provide technical data sheets and associated drawings			
Conductor	• BS EN 60228			
Water blocking material mechanical connector compatibility	• Remove: • Leave in-situ:			
Conductor Screen Resistivity	• ENATS 09:17: clause 2.3.1.1 • BS 7870 4.10: clause 8.1.1			
Conductor Screen, Insulation & Insulation Screen:	• Continuous single pass triple extrusion (free from factory repairs)			
	• Dry Cured Cross Linking			
- Concentricity & Circularity	• BS 7870 4.10: clause 7.4 • ENATS 09:17: clauses 2.1.3 and 2.1.4			
Insulation Thickness	• BS 7870 4.10: clause 4.2.3 (Table 1) • ENATS 09:17: clause 2.1.3			
Insulation Test	• ENATS 09:17: clause 2.3.1.2 (Table 3) • BS 7870 4.10: clause 8.1.2			
Insulation Shrinkage	• Shall not exceed 4% (refer to table 6: ENATS 09:17 & BS 7870 4.10 clause 7.3 for test methods)			
Insulation Screen: - Resistivity	• ENATS 09:17: clause 2.3.1.3 • BS 7870 4.10: clause 8.1.3			
	• Fully Bonded			
Screen	• Min 35mm² Cu			
Longitudinal – Tapes Moisture - Moisture Blocking: Tapes - Content Moisture Penetration Test	• Under and Over Metallic Screen Wires			
	• ≤ 50 000 PPM			
	• Al conductors to be longitudinally blocked			
	• BS 7870-4.10: clause 7.8.3			
Oversheath :	• Extruded MDPE to BS 7870 Part 4.10 & Density as ENATS 09:17			

NPS/002/021 – Technical Specification for 33kV Power Cables				
	Clause / Requirements	**Conformance Code**	**Evidence Reference**	**Remarks / Comments**
- Tests	• Coloured Black			
	• ENATS 09:17: clause 2.3.1.4 • BS 7870 4.10: clause 8.1.6			
	• Max 2% (Refer to BS 7870 4:10 for test methods)			
Cable marking 3.3.5	• Unique Identification number and meter marked			
	• L1, L2, and L3, marked externally, and Brown Black or Grey marker tapes applied internally on Triplex cables			
Compatibility Test	• ENATS 09:17: clause 2.3.1.5 • BS 7870 4.10: clause 8.1.9			
Partial Discharge Test	• ENATS 09:17: clause 2.3.2.1 • BS 7870 4.10: clause 8.2.2			
Bending Test	• ENATS 09:17: clause 2.3.2.2 • BS 7870 4.10: clause 8.2.3			
Power Factor Test	• ENATS 09:17: clause 2.3.2.3 • BS 7870 4.10: clauses 8.2.4 / 8.2.5			
Heat Cycling Test	• ENATS 09:17: clause 2.3.2.4 • BS 7870 4.10; clause 8.2.6			
Impulse Withstand Test	• ENATS 09:17: clause 2.3.2.5 • BS 7870 4.10: clause 8.2.7			
4 Hr Voltage Test	• ENATS 09:17: clause 2.3.2.6 • BS 7870 4.10: clause 8.2.8			
Screen Adherence @ SC	• ENATS 09:17: clause 2.3.2.7 • BS 7870 4.10: clause 8.4			
Cold Bend Test	• ENATS 09:17: clause 2.3.2.8 • BS 7870 4.10: clause 8.1.10			
Long Term Ageing	• CIGRE / CENELEC HD 605			

Appendix 3 – Addendum to Supplier Requirements

For each power cable offered the Tenderer shall provide the following cable rating data using the operating conditions presented below: -

- Single core cables are laid in touching trefoil
- Cover to top of cables being 910mm
- Ground Thermal Resistivity = 1.2 K m/W
- Ground temperature = 15^0C
- Air temperature = 25^0C
- Maximum conductor operating temperature = 90^oC

Supplier Requirements				
Clause	**Requirement**	**Conformance Code (Y/N)**	**Evidence Reference**	**Remarks**
Cable Rating Data	Cable rating laid direct (Amps)			
Cable Rating Data	Cable rating laid in a 150mm internal diameter duct (Amps)			
Cable Rating Data	Cable rating in air (Amps)			
Cable Rating Data	The 3 ph symmetrical short circuit and phase to earth short circuit rating			
Cable Rating Data	Maximum dc resistance per phase conductor at 20^0C (Ohms/km)			
Cable Rating Data	Maximum ac resistance per phase conductor at maximum conductor temperature (Ohms/km)			
Cable Rating Data	Star reactance at 50Hz (Ohms/km)			
Cable Rating Data	Star capacitance at 50Hz (Ohms/km)			
Cable Rating Data	Charging current per phase at normal voltage and frequency (mA/m)			
Cable Rating Data	Zero sequence impedance $R_0 + jX_0$ (Ohms/km)			
Cable Installation Data	Minimum dynamic bending radius (mm) (In triplex, trefoil and single core formations)			
Cable Installation Data	Minimum static bending radius (mm)			

Supplier Requirements				
Clause	**Requirement**	**Conformance Code (Y/N)**	**Evidence Reference**	**Remarks**
Cable Rating Data	The minimum average insulation thickness			
Cable Rating Data	The maximum electrical stress on the conductor screen and insulation screen			
Cable Installation Data	Recommended pulling method, maximum pulling tension (kgF) and duct sizes, including;			
	- All cables in triplex formation into ducts			
	- All single core cables in trefoil formation into ducts			
Cable Oversheath Marking	The oversheath of all cables shall be marked in accordance with the requirements of the relevant Standard specified in this document.			
Cable Metre Marking	All cables shall be metre marked throughout the length of the cable and the start and end values shall be marked on the drum label.			
Cable Reference Number Marking	Cables shall be marked with some form of reference or batch number that can be used to ensure batch trace ability of materials and manufacturing facilities used in the construction of the cable.			

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 periodic inspection and maintenance requirements to be undertaken during the lifetime of their product.

Detailed inspection and maintenance instructions shall also be provided.

Testing, inspection or maintenance				
Clause	**Requirement**	**Conformance Code (Y/N)**	**Evidence Reference**	**Remarks**
Pre commissioning Testing	Please state any pre commissioning tests			
Routine Inspection	Please state any inspections required during life time of the cable			
Routine Maintenance	Please state any routine maintenance required during the normal expected life of the cable			

Appendix 5 – Logistical Requirements

Drums used for 33kV power cables shall have the following dimensions and weights as shown in the table below. Where dimensions and weights are not provided, then confirmation shall be agreed with the Logistics department on an individual basis.

Cable Type	Commodity Code	Recommended* Max Drum Size (Height/Dia) (mm)	Recommended* Max Drum Size (Width) (mm)	Recommended* Maximum Laden Drum Weight (kg)
33kV Single Core				
300mm^2 Circular Stranded Copper Conductor	018442	2200	1200	3500
400mm^2 Circular Stranded Copper Conductor	018457	2200	1200	3500
500mm^2 Circular Stranded Copper Conductor	018523	2200	1200	3500
630mm^2 Circular Stranded Copper Conductor	018531	2200	1200	3500
800mm^2 Circular Stranded Copper Conductor	108951	2200	1200	3500
500mm^2 Circular Stranded Aluminium Conductor	108952	2200	1200	3500
630mm^2 Circular Stranded Aluminium Conductor	108953	2200	1200	3500
800mm^2 Circular Stranded Aluminium Conductor	108954	2200	1200	3500
33kV Triplex Formation				
300mm^2 Circular Stranded Copper Conductor	018448	2200	1200	3500
400mm^2 Circular Stranded Copper Conductor	108955	2200	1200	3500

***** Drum sizes and weights are in line with general supply requirements to 'The Company' Stores and Warehouses. Drum sizes, weights and lengths may vary, determined by projects/schemes on an individual basis. Facilities to manage cable drum sizes, weights and lengths outside of the table recommendations shall be agreed prior to delivery.

All cable drums shall be returnable and the tenderer shall arrange to collect empty drums from the company's normal delivery locations.

Tenderers shall state at the time of tender their proposed cable drum sizes and weights for each cable type offered.

All cable drums shall be marked in accordance with the relevant cable Specification or Standard. The drum label shall also contain;

(a) Customers catalogue number

(b) Name of manufacturer

(c) Supplied length

(d) Rated voltage

(e) Number of cores

(f) Size of conductor

(g) Type of conductor material ("Cu" or "Al")

(h) Abbreviated description of cable construction

(I) Gross and nett weights

(j) Direction of rolling drum

(k) The metre marking starts and end values

(l) The unique reference number

Cable drums may be stored for long period's outdoors. All cable drums shall be constructed of materials that allow outdoor storage without undue degradation that would deem them unusable. Manufacturers/suppliers shall provide defined conditions for storage. The drum construction shall be suitably robust and fee from any protrusions such as nails or sharp edges, which may cause injury when handling. All drum labels shall remain legible and durable under these conditions.

The ends of all cables shall be effectively sealed against the ingress of moisture by a method appropriate to the cable type. Tenderers shall detail at the time of tender their proposed sealing arrangement for each cable type offered.

The cable end projecting from the drum shall be protected from damage during transit, storage and handling on site.

The cable on the drum shall not be susceptible to damage during transit, storage and handling on site.

Tenderers shall state at the time of tender their proposed method of protection for each cable.

Each delivery length of cable shall be allocated a unique reference number. This number shall appear on the factory test sheet covering the cable length, shall be clearly marked on the drum on which the length is delivered and shall be referred to on all invoices and advice notes.

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)
Appendix 2 – Self Certification Conformance Declaration	
• Full product descriptions and part number/reference	
• Complete set of technical data sheets and associated drawings	
• Completed self-certification conformance declaration including all associated type test data	
Appendix 3 – Addendum to Supplier Requirements	
• Provide additional information as specifically requested:	
○ Cable Rating Data	
○ Cable Installation Data (up to max sizes in all formations)	
○ Cable Oversheath Marking	
○ Cable Metre Marking	
○ Cable Reference Number Marking	
Appendix 4 – Pre-commission Testing, Routine Inspection and Maintenance Requirements	
• If required please provide details for:	
○ Pre-commission testing	
○ Routine inspection requirements	
○ Routine maintenance requirements	
○ Manufacturing Quality Plan or Routine Test Plan	
Appendix 5 – Logistical Requirements	
• Provide logistical details with regard to packaging / delivery information and requirements	