NPS/002/020 – Technical Specification for 11 & 20kV Power Cables

1. Purpose

The purpose of this document is to detail Northern Powergrid's (the Company) requirements for 11kV and 20kV underground cable for use on distribution network.

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

Document Reference	Document Title	Version	Published Date
NPS/002/020	Technical Specification for 11 & 20kV Power Cables	4.3	July 2019

2. Scope

This specification details the type, size and requirements for 11kV and 20kV power cables for use on the Company's distribution network.

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 Types Utilised
- 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 will be laid "direct" into the ground, pulled into buried ducts, open trenches or installed in air. During storage and after installation cables can be expected to be subjected to the full range of climatic conditions encountered in the UK.

Cable laid "direct", in ducts or trenches may be surrounded by ground water for most of their operating lives. Cables installed above ground will be supported by means of cleats either vertically or horizontally and may be exposed to direct sunlight for significant periods. Where installed on wood poles these cables may come into contact with a pole preservation medium such as creosote.

Accessories required to joint the cable 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/001/912 - Code of Practice for the Economic Development of the HV 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 11kV and 20kV power cables:

- Nominal system voltages: 11kV and 20kV.
- All cables and associated equipment for use on the system shall be rated at a minimum of:
    - 12kV for use on systems with a nominal voltage of 11kV, and,
    - 24kV for use on systems with a nominal voltage of 20kV.
- Fault rating (phase to earth): 11kV and 20kV.
    - 11kV shall be 5kA for 2 seconds, and,
    - 20kV shall be 2kA for 3 seconds.
- All cables and associated equipment for use on the system shall have a minimum Basic Impulse Level (lightning withstand) of:
    - 95kV for use on systems with a nominal system voltage of 11kV, and,
    - 125kV for use on systems with a nominal system voltage of 20kV.
- 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.

3.3. 11kV and 20kV Distribution Cables – Extruded Insulation

11kV and 20kV distribution cables of single core extruded insulation design are required in both "true single core" and in "triplex" configurations with conductor sizes as specified in Appendix 1.

Cables shall comply in all respects with the requirements of BS 7870: 4.10 and meet any additional requirements specified in ENATS 09-17.

3.3.1. Conductors

The cable conductors shall be circular solid aluminium or, circular compacted, stranded copper in accordance with BS EN 60228. The range of conductor cross sections required is as detailed in Appendix 1.

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 will be completely “Dry Cured” and no water will be used during this process. Maximum permissible shrinkage shall be 2%.

For designs with XLPE insulation, the insulation screen shall be of the "fully bonded" type. Insulation thickness for 11kV cables shall comply with requirements of BS 7870: 4.10 and any additional requirements of ENATS 09-17. Insulation thickness for 20kV cables shall comply with the requirements of BS6622 - 12.7/22(24) kV cables.

All cables shall comply with the concentricity and circularity requirements of BS 7870: 4.10 and meet any additional requirements specified in ENATS 09-17.

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 installed in the case of both 11kV and 20kV cables.

Moisture blocking tape shall be provided under and over the copper wires to provide radial and 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 IEC 60840: 2011.

3.3.4. Oversheath

The oversheath (coloured red for 11kV cables and black for 20kV cables) - shall consist of an extruded layer of MDPE complying with the requirements of BS 6234 and the relevant sections of BS 7870 part 4.10. Maximum permissible shrinkage shall be 2%. The compound shall have a density within the range quoted in ENATS 09-17.

An outer graphite coating is not required.

3.3.5. Internal and External Cable Marking

Oversheath embossing and printing for both 11kv and 20kV 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/batch number. This unique number and shall be embossed or printed on the cable near to the metre mark. This unique number will be used to identify all materials used within the manufacturing process. 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.

The text “Northern Powergrid“ shall be embossed or indented onto the cable.

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 below the PE sheath. These marker tapes shall not compromise the integrity of the water swellable tapes.

All external marking must be clearly visible.

3.3.6. Long Term Ageing

Cable designs must have successfully undergone CIGRE long term ageing tests as per proposed 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 6234 (withdrawn for reference)	Specification for polyethylene insulation and sheath of electric cables
BS 6622	Electric Cables – Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6kV to 19/33kV – Requirements and test methods
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 volts and 19000/33000 volts
IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um = 36kV) up to 150kV (Um = 170kV) – Test methods and requirements

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/001/912	Code of Practice for the Economic Development of the HV System
NSP/002	Policy for the Installation of Distribution Power Cables

4.3. Amendments from Previous Version

Reference	Title
6 – Authority for Issue	List updated
Appendix 1 – Cable Types Utilised	New items added
Appendix 5 – Logistical Requirements	Table updated
Appendix 5 – Logistical Requirements	New items added

5. Definitions

Term	Definition
The Company	Northern Powergrid

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	10/01/2022

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: To align with proposed contract award period
Should this document be displayed on the Northern Powergrid external website?		Yes

		Date
Steven Salkeld	Policy and Standards Engineer	10/01/2022

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
David Gazda	Senior Policy and Standards Engineer	11/01/2022
Joseph Helm	Policy and Standards Manager	10/01/2022

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	System Engineering Manager	13/01/2022

Appendix 1 – Cable Types Utilised

The following list of cables types aligns with the requirements of IMP/001/912 - Code of Practice for the Economic Development of the HV System.

Cable Type	Commodity Code
11kV Single Core	
185mm^2 Circular Solid Aluminium Conductor	110396
300mm^2 Circular Stranded Copper Conductor*	016414
400mm^2 Circular Stranded Copper Conductor*	110397
500mm^2 Circular Stranded Copper Conductor	016416
630mm^2 Circular Stranded Copper Conductor*	016418
800mm² Circular Stranded Copper Conductor	016422
11kV Triplex Formation	
95mm^2 Circular Solid Aluminium Conductor	110398
185mm^2 Circular Solid Aluminium Conductor*	110399
300mm^2 Circular Solid Aluminium Conductor*	110400
300mm^2 Circular Stranded Copper Conductor	016412
400mm^2 Circular Stranded Copper Conductor	107224
20kV Single Core	
400mm^2 Circular Stranded Copper Conductor*	108927
800mm² Circular Stranded Copper Conductor	016420
20kV Triplex Formation	
185mm^2 Circular Solid Aluminium Conductor*	110097
300mm^2 Circular Stranded Copper Conductor	107223
400mm^2 Circular Stranded Copper Conductor	110098

* These 11kV and 20kV cable types presented in the above table align with the standard design requirements of IMP/001/912 - Code of Practice for the Economic Development of the HV 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

11 and 20 kV 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.

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 the evidence confirming 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/002/020 – Technical Specification for 11 & 20kV Power Cables				
	Clause / Requirements	**Conformance Code**	**Evidence Reference**	**Remarks / Comments**
Technical Data	• Provide technical data sheets and associated drawings			
Conductor	• BS EN 60228			
Conductor Screen Resistivity	• ENATS 09:17 2.3.1.1 • BS 7870 4.10 8.1.1 • BS 6622 19.2			
Conductor Screen, Insulation & Insulation Screen:	• Continuous single pass triple extrusion (free from factory repairs)			
	• Dry Cured Cross Linking			
- Concentricity & Circularity	• BS 7870 4.10 7.4 • ENATS 09:17 2.1.4 • BS 6622 18.7			
Insulation Thickness -11kV	• BS 7870 4.10 4.2.3 • ENATS 09:17 2.1.3			
-20kV	• BS 6622 7 (Table 1)			
Insulation Test	• ENATS 09:17 2.3.1.2 (Table 3) • BS 7870 4.10 8.1.2			
Insulation Shrinkage	• Max 2% (refer to table 6: ENATS 09:17 & BS 7870 4.10 for test methods).			
Insulation Screen: - Resistivity	• ENATS 09:17 2.3.1.3 • BS 7870 4.10 8.1.3 • BS 6622 19.4			
	• Fully Bonded			
Screen	• Min 35mm² Cu			
Longitudinal - Tapes	• Under and Over Metallic Screen Wires			
Moisture - Moisture Blocking: Tapes - Content	• ≤ 50 000 PPM			
Moisture Penetration Test	• IEC 60840			
Oversheaths :	• Extruded MDPE to BS 6234, BS 7870 Part 4.10 & Density as ENATS 09:17			

NPS/002/020 – Technical Specification for 11 & 20kV Power Cables				
	Clause / Requirements	Conformance Code	Evidence Reference	Remarks / Comments
- 11kV Cables - 20kV Cables - Tests	• Coloured Red			
	• Coloured Black			
	• ENATS 09:17 2.3.1.4 • BS 7870 4.10 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			
	• Northern Powergrid embossed or indented on the cable			
	• L1, L2, and L3 marked externally and Brown Black or Grey marker tapes applied internally on Triplex cables			
Compatibility Test	• ENATS 09:17 2.3.1.5 • BS 7870 4.10 8.1.9 • BS 6622 19.3			
Partial Discharge Test	• ENATS 09:17 2.3.2.1 • BS 7870 4.10 8.2.2 • BS 6622 17.5			
Bending Test	• ENATS 09:17 2.3.2.2 • BS 7870 4.10 8.2.3 • BS 6622 20.3			
Power Factor Test	• ENATS 09:17 2.3.2.3 • BS 7870 4.10 8.2.4 / 8.2.5 • BS 6622 20.4 / 20.5			
Heat Cycling Test	• ENATS 09:17 2.3.2.4 • BS 7870 4.10 8.2.6 • BS 6622 20.6			
Impulse Withstand Test	• ENATS 09:17 2.3.2.5 • BS 7870 4.10 8.2.7 • BS 6622 20.7			

NPS/002/020 – Technical Specification for 11 & 20kV Power Cables				
	Clause / Requirements	Conformance Code	Evidence Reference	Remarks / Comments
4 Hr Voltage Test	• ENATS 09:17 2.3.2.6 • BS 7870 4.10 8.2.8 • BS 6622 20.8			
Screen Adherence @ SC	• ENATS 09:17 2.3.2.7 • BS 7870 4.10 8.4 • BS 6622 20.9			
Cold Bend Test	• ENATS 09:17 2.3.2.8 • BS 7870 4.10 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 11kV cables being 600mm
- Cover to top of 20kV cables being 600mm
- 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	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 Rating Data	Minimum dynamic bending radius (mm) (In Triplex			

Supplier Requirements				
Clause	**Requirement**	**Conformance Code (Y/N)**	**Evidence Reference**	**Remarks**
	and single core formations)			
Cable Rating Data	Minimum static bending radius (mm)			
Cable Rating Data	Recommended pulling method and maximum pulling tension (kgF)			
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 be also be provided.

Testing ,inspection or maintenance		
Clause	**Requirement**	**Details**
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 11 and 20kV 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 and Project Manager on an individual basis.

Cable Type	Commodity Code	Suggested Max Drum Size (Height) (Dia mm)	Suggested Max Drum Size (Width) (mm)	Maximum Drum Weight (kg)	Maximum Quantity On A Drum (m)
11kV Single Core					
185mm^2 Circular Solid Aluminium Conductor	110396	2200	1200	2000	250
300mm^2 Circular Stranded Copper Conductor*	016414	2200	1200	2000	250
400mm^2 Circular Stranded Copper Conductor*	110397	2200	1200	2000	250
500mm^2 Circular Stranded Copper Conductor	016416	2200	1200	4000	250
630mm^2 Circular Stranded Copper Conductor*	016418	2200	1200	tba	250
800mm^2 Circular Stranded Copper Conductor	016422	2200	1200	tba	250
11kV Triplex Formation					
95mm^2 Circular Solid Aluminium Conductor	110398	2200	1200	2000	250
185mm^2 Circular Solid Aluminium Conductor*	110399	2200	1200	2000	250
300mm^2 Circular Solid Aluminium Conductor*	110400	2200	1200	2000	250
300mm^2 Circular Stranded Copper Conductor	016412	2200	1200	3500	250
400mm^2 Circular Stranded Copper Conductor	107224	2200	1200	tba	250
20kV Single Core					
400mm^2 Circular Stranded Copper Conductor*	108927	2200	1200	tba	250
800mm^2 Circular Stranded Copper Conductor	016420	2200	1200	tba	250
20kV Triplex Formation					
185mm^2 Circular Solid Aluminium Conductor*	110097	2200	1200	2000	250
300mm^2 Circular Stranded Copper Conductor	tbc	2200	1200	tba	250
400mm^2 Circular Stranded Copper Conductor	110098	2200	1200	tba	250

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) Northern Powergrid 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 net weights

(j) Direction of rolling drum

(k) The metre marking start and end values

(l) The unique reference/batch number

Cable drums may be stored for long periods outdoors. 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 cable technical data sheets and associated drawings	
• Completed self-certification conformance declaration including all associated type test data	
• Product Quality Plan	
Appendix 3 – Addendum to Supplier Requirements	
• Provide additional information as specifically requested	
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	
Appendix 5 – Logistical Requirements	
• Provide logistical details with regard to packaging / delivery information and requirements	