

# Electricity Specification 400C11

Issue 8      August 2024

## Low Voltage Mains Cables



## Amendment Summary

| ISSUE NO.<br>DATE                    | DESCRIPTION  |
|--------------------------------------|--|
| <b>Issue 7</b><br><b>July 2021</b>   | <p>An additional requirement for the maximum insulation thickness has been added in <a href="#">Section 10.3.3</a> to ensure insulating piercing connectors work satisfactory with the waveform cables. Other minor changes as marked.</p> <p>Prepared by: David M Talbot<br/>           Approved by: Policy Approval Panel<br/>           and signed on its behalf by Steve Cox, Engineering and Technical Director</p> |
| <b>Issue 8</b><br><b>August 2024</b> | <p>Updated to new ES template<br/>           No technical content changed</p> <p>Prepared by: P Howell<br/>           Approved by: Policy Approval Panel<br/>           and signed on its behalf by Paul Turner, PAP Chairperson</p>   |

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## 1 Scope

This Specification covers the technical requirements for Low Voltage (LV) mains cables for use on the Electricity North West Limited (hereinafter referred to as Electricity North West) Distribution System.

## 2 Definitions

|                       |  |
|-----------------------|--|
| <b>Approval</b>       | Sanction by the Electricity North West Underground Circuits Manager that specified criteria have been satisfied  |
| <b>Contract</b>       | The agreement between Electricity North West and the Contractor for the execution of the Works including therein all documents to which reference may properly be made in order to ascertain the rights and obligations of the parties under the said agreement.   |
| <b>Contractor</b>     | The person or person's firm or company, including personal representatives, successors and permitted assigns, who's Tender has been accepted by Electricity North West.  |
| <b>PVC</b>            | Poly Vinyl Chloride  |
| <b>Specification</b>  | The Specifications and schedules (if any) agreed by the parties for the purpose of the Contract.   |
| <b>Sub-Contractor</b> | Any person (other than the Contractor) named in the Contract for any part of the Works or any person to whom any part of the Contract has been sub-let with the consent in writing of the Electricity North West Underground Circuits Manager, and the legal representatives, successors and assigns of such person. |
| <b>Supplier</b>       | Any person or person's firm or company who supplies goods to Electricity North West or to its Contractor.  |
| <b>Tender</b>         | An offer in writing to execute work or supply goods at a fixed price.  |
| <b>Tenderer</b>       | The person or person's firm or company, including personal representatives, successors and permitted assigns, invited by Electricity North West to submit a Tender.  |
| <b>XLPE</b>           | Cross linked Polyethylene  |

### **3 General Requirements for Approvals and Testing**

#### **3.1 Product not to be Changed**

Compliance with this clause shall be in accordance with ES001.

#### **3.2 Electricity North West Limited Technical Approval**

Compliance with this clause shall be in accordance with ES001.

#### **3.3 Quality Assurance**

Compliance with this clause shall be in accordance with ES001.

#### **3.4 Formulation**

Compliance with this clause shall be in accordance with ES001.

#### **3.5 Identification Markings**

Compliance with this clause shall be in accordance with ES001.

#### **3.6 Minimum Life Expectancy**

The minimum life expectancy of all products covered by this Specification is 60 years.

#### **3.7 Product Conformity**

Compliance with this clause shall be in accordance with ES001.

#### **3.8 Confirmation of Conformance**

The Tenderer shall complete the conformance declaration sheets in [Appendix B](#).

Failure to complete these declaration sheets may result in an unacceptable bid.

### **4 Requirements for Type and Routine Testing**

Compliance with this clause shall be in accordance with ES001.

#### **4.1 Requirement for Type Tests at Suppliers Premises**

Compliance with this clause shall be in accordance with ES001.

#### **4.2 Requirement for Routine Tests at the Supplier's Premises**

Compliance with this clause shall be in accordance with ES001

## 5 Conditions of Installation

Cables specified in this Specification 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.

Cables may be surrounded by ground water for most of their operating life. Where cables are 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 either vertically or horizontally and these cables may be exposed to direct sunlight for significant periods.

Cables may be installed on wood poles in contact with the pole and, therefore, in contact with a pole preservation medium such as creosote.

Accessories may be cold applied or require application of heat.

## 6 Conditions of Operation for Power Cables

The following are the general conditions under which power cables purchased in accordance with this Specification are required to operate:

- Nominal system voltage 400/230 volts
- The working voltage of any part of the system does not normally exceed the normal system voltage by more than 10%.
- 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.

## 7 Cable Longevity

Reliability is paramount. When any Tender for LV mains cables is evaluated, preference will be given to proven established designs.

The Supplier shall demonstrate reliability for the offered design of the cable by providing evidence of satisfactory service life.

Cables offered shall be designed and manufactured to operate satisfactorily under the installation and operating conditions detailed in Section 5 and 6.

## 8 Technical Particulars

### 8.1 Technical Requirements

Where a requirement of this Specification differs from that of another quoted Specification or Standard, the requirements of this Specification shall apply.

If a Tenderer is unsure regarding any requirement of this Specification, clarification shall be sought in writing from Electricity North West.

### 8.2 Cable Design

This Specification covers the supply of the following types of Low Voltage Mains cables:

- (a) Single phase; 400mm<sup>2</sup> Copper, XLPE insulated, unarmoured with PVC sheathed cable to BS7889
- (b) Single phase; 400mm<sup>2</sup> Copper, XLPE insulated, aluminium wire armoured with PVC sheathed cable to BS5467
- (c) Three and four core; 95, 185 and 300mm<sup>2</sup> Aluminium, XLPE insulated, copper wire waveform cable with PVC sheath to BS7870-3.40
- (e) Three and four core; 95, 185 and 300mm<sup>2</sup> Aluminium, XLPE insulated, copper wire waveform cable with LSOH sheath to BS7870-3.50

### 8.3 Conductors

Phase conductors for single core cables shall be round stranded copper and shall comply to the requirements for stranded conductors (class 2) as specified in BS EN 60228.

Phase conductors for 3 and four core waveform cables shall be sectoral shaped solid aluminium and shall comply to the requirements for solid conductors (class 1) as specified in BS EN 60228. The conductors shall also conform to the dimensional requirements specified in BS EN 60228 or BS 3988. The Supplier shall confirm which shape of conductor is being offered and to what specification.

### 8.4 Insulation

The maximum permissible shrinkage of insulation on all Low Voltage Mains cables shall be 2%. The test shall be carried out at both 65°C for 24 hours and 130°C for 1hour.

Single phase Low Voltage Mains cables insulation shall be XLPE type GP 8 conforming to BS 7655-1.3, or type GP 6 conforming to BS 7655-1.2.

Single phase cables shall have black insulation.

Three or four core cables Phase core insulation shall be XLPE type DIX 3 complying with the requirements of BS 7870-1 Annex B.

Three phase Waveform Mains Cables shall have the cores laid up with a right-hand direction of lay in the sequence brown, black, grey for three core cables, and brown, black, grey, blue for four core cables.



Phase core insulation for three and four waveform cable types shall have a minimum average insulation thickness as defined in BS 7870-3.40 or 3.50 and in addition, the maximum insulation thickness at any point around the conductor shall be no more than the following values:

| CABLE CONDUCTOR CROSS SECTION                | MAXIMUM INSULATION THICKNESS AT ANY POINT |
|--|---|
| 95 mm <sup>2</sup> Solid Sectoral Aluminium  | 1.5mm                                     |
| 185 mm <sup>2</sup> Solid Sectoral Aluminium | 2.0mm                                     |
| 300 mm <sup>2</sup> Solid Sectoral Aluminium | 2.2mm                                     |

## 8.5 Waveform Copper Wires

Three and four core waveform cables shall have plain annealed copper wires applied in waveform embedded on synthetic rubber. The wire diameter and formation shall comply with the requirements in BS7870-3.40 or BS7870-3.50.

The copper wires shall not stick to the synthetic bedding layer.

## 8.6 Oversheath

For single core cables, the oversheath shall be an extruded layer of black PVC material conforming to the requirements of Type 9 specified in BS 7655-4.2.

For three and four core waveform cables, depending on the specific cable, the oversheath shall be either:

- a) an extruded layer of black PVC DMV 23 complying to the requirements of BS 7870-1 Annex B and applied so that there is no internal protrusion of the oversheath material around the copper waveform wires.  
or.
- b) an extruded layer of orange Low Smoke, zero halogen (LSOH) compound to type DMZ 4 to BS 7870-1, Annex B and applied so that there is no internal protrusion of the oversheath material around the copper waveform wires.

In addition to the requirements for oversheath markings detailed in the relevant specification for each cable supplied, a unique reference number shall be embossed, indented or ink jet marked on the cable oversheath.

## 8.7 Cable Identification

Each delivery length of cable shall be allocated a unique reference number. This unique reference number shall be marked on the cable. This unique reference 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.

## 9 Manufacturing

At the time of Tender, the Tenderer shall provide details of manufacturing location(s) for each cable offered. For cables with extruded insulation, the Tenderer shall also provide details of extrusion and curing technology for each cable offered. The cross-linking process will be completely “Dry Cured” and no water will be used during this process.

Any Approval granted will be site specific and will not be transferable to any other site without the prior written agreement of the Electricity North West Underground Circuits Manager.

## 10 Type Tests

All cables offered shall be fully Type Tested and Qualified according to the requirements of the Technical Specification and Standards detailed for each cable type. The Tenderer shall provide Type Test certificates and Type Test reports, including details of independent witnesses, at the time of Tender.

Where a Tenderer wishes to offer a cable which has been Type Tested to an alternative Standard(s), full details of the alternative Standard(s) and how it differs from the Specified Standard(s) shall be provided at the time of Tender along with Type Test certificates.

## 11 Logistical Requirements

### 11.1 Cable Drums

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

Drums used for LV Mains cables shall have a maximum width of 1200mm and a maximum weight of 2500kg.

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.

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.

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

### 11.2 Drum labels

All cable drums shall be marked in accordance with the relevant cable specification or standard. The drum label shall also contain:

- Electricity North West commodity code
- Name of manufacturer

- Supplied length
- Rated voltage
- Number of cores
- Size of conductor
- Type of conductor material ("Cu" or "Al")
- Abbreviated description of cable construction
- Gross and nett weights
- Direction of rolling drum
- The metre marking start and end values
- The unique reference number

Cable drums may be stored for long periods outdoors. All drum labels shall remain legible and durable under these conditions

## 12 Technical Support

The required minimum level of support is as follows:

- Contractual or technical advice is to be available, in English, by telephone during normal working hours.
- Attendance at site by the manufacturer, or the manufacturer's representative within 5 working days of any request made by ENWL following identification of a defect or other major issue relating to the cable.

Tenderers shall provide details of the support available including contact details of Technical Support operatives.

## 13 Samples

During the Tender period the Tenderer shall submit samples for Approval as required by the Electricity North West Underground Circuits Manager. The samples will be of reasonable lengths to allow for any testing on suitability for the ENWL cable jointing system to be made.

Such samples shall remain the property of Electricity North West.

## 14 Cable Data Sheets

The Tenderer shall supply full Technical Data sheet for each cable type, detailing the following information:

- Cable Construction including cross sectional drawing
- Maximum dc resistance of phase conductor at 20°C in ohm/km.
- Maximum ac resistance of phase conductor at maximum conductor temperature in ohm/km.
- Equivalent star reactance at 50 Hz in ohm/km.
- Equivalent star capacitance in pF/km.
- Charge current per phase at normal voltage and frequency in mA/m.
- Zero sequence impedance  $R_0 + jX_0$  in ohms/km.
- Minimum dynamic bending radius in mm.
- Minimum static bending radius in mm.
- Recommended pulling method and maximum pulling tension in kgF.
- The maximum continuous current carrying capacity per phase conductor for the following conditions:
  - a) In Air (shaded with no solar gain)
  - b) Laid direct in ground with Ground thermal resistivity ( $g$ ) = 1.2 °C/W (see Note)
  - c) Laid direct in ground with Ground thermal resistivity ( $g$ ) = 0.9 °C/W (see Note)
  - d) Drawn into a 150mm ID smooth wall plastic duct (one cable per duct) where  $g$  = 1.2 °C/W (see Note)
  - e) Drawn into a 150mm ID smooth wall plastic duct (one cable per duct) where  $g$  = 0.9 °C/W (see Note)

The following assumptions shall be made when quoting ratings:

- Single core cables are laid in touching trefoil.
- Depth of cover to top of LV cables is 500mm.
- Ground temperature = 15 °C.
- Air temperature = 25 °C.

Note – Data for conditions b), c), d) and e) are not required for single core 400mm<sup>2</sup> versions.

## 15 Documents Referenced

| DOCUMENTS REFERENCED  |  |
|---|--|
| <b>Health and Safety at Work Act 1974</b>                         |  |
| <b>Control of Substances Hazardous to Health Regulations 2002</b> |  |
| <b>Manual Handling Operations Regulations 1992</b>                |  |
| <b>BS EN ISO 9000:</b>  | Quality Management Systems.  |
| <b>BS EN ISO 14001: 2015</b>                                      | Environmental management systems. Requirements with guidance for use   |
| <b>BS 5467: 1997:</b>   | Specification for 600/1000 V and 1900/3300 V Armoured Electric Cables having Thermosetting Insulation.   |
| <b>BS EN 60228:</b>   | Conductors of insulated cables.  |
| <b>BS 7655:</b>   | Insulation and sheathing materials for cables.   |
| <b>BS 7870 -1</b>   | LV and MV polymeric insulated cables for use by distribution and generation utilities.   |
| <b>BS 7870 -3.40</b>  | Section 3.40: XLPE insulated, copper wire waveform concentric cables with solid aluminium conductors   |
| <b>BS7870- 3.50</b>   | Section 3.50: XLPE insulated, copper wire waveform or helical concentric cables with solid aluminium conductors, having low emission of smoke and corrosive gases when affected by fire. |
| <b>BS 7889:</b>   | Specification for 600/1000 V Single-Core Unarmoured Electric Cables having Thermosetting Insulation.   |
| <b>CP311:</b>   | Equipment Approval Process.  |
| <b>ES001:</b>   | Main Specifications  |

## 16 Keywords

Cable; Waveform; XLPE; PVC; LV Mains

## Appendix A – Schedule of Cables

| ITEM | ORDERING SPECIFICATION   | CONDUCTOR SIZE (mm <sup>2</sup> ) | ENWL Commodity Code        |
|------|--|-----------------------------------|----------------------------|
| 1    | Cable, LV, single core, XLPE insulated, unarmoured to BS7889 (for use as transformer tails in <u>indoor</u> substations) | 400                               | 995246                     |
| 2    | Cable, LV, single core; XLPE insulated, armoured to BS5467 (for use as transformer tails in <u>outdoor</u> substations)  | 400                               | 995247                     |
| 3    | Cable, LV, 3 core, waveform with PVC sheath to BS7870-3.40   | 95<br>185<br>300                  | 003697<br>003700<br>003727 |
| 4    | Cable, LV, 4 core, waveform with PVC sheath to BS7870.3.40   | 95<br>185<br>300                  | 003735<br>000701<br>003759 |
| 5    | Cable, LV, 3 core, waveform with LSOH sheath to BS7870-3.50 for enhanced fire performance                                | 95<br>185<br>300                  | 329253<br>995255<br>995256 |
| 6    | Cable, LV, 4 core, waveform with LSOH sheath to BS7870-3.50 for enhanced fire performance                                | 95<br>185<br>300                  | 003760<br>003761<br>003762 |

## Appendix B – Conformance Declaration

### SECTION-BY-SECTION CONFORMANCE WITH SPECIFICATION

The Tenderer shall declare conformance or otherwise for each product/service or range of products/services, section-by-section, using the following Conformance Declaration Codes.

**Conformance Declaration Codes:**

|              |  |
|--------------|--|
| <b>N/A =</b> | Clause is not applicable/appropriate to the product/service.   |
| <b>C1 =</b>  | The product/service conforms fully with the requirements of this clause.   |
| <b>C2 =</b>  | The product/service conforms partially with the requirements of this clause.   |
| <b>C3 =</b>  | The product/service does not conform to the requirements of this clause.   |
| <b>C4 =</b>  | The product/service does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform. |

**Manufacturer:**

**Product/Service Description:**

**Product/Service Reference:**

**Name:**

**Company:**

**Signature:**

**SECTION-BY-SECTION CONFORMANCE**

| Section | Section Topic                             | Conformance Declaration Code | Remarks *<br>(must be completed if code is not C1) |
|---------|---|------------------------------|--|
| 3.1     | Product not to be Changed                 |                              |  |
| 3.2     | Electricity North West Technical Approval |                              |  |
| 3.3     | Quality Assurance                         |                              |  |
| 3.4     | Formulation                               |                              |  |
| 3.5     | Identification Markings                   |                              |  |
| 3.6     | Minimum Life Expectancy                   |                              |  |
| 3.7     | Product Conformity                        |                              |  |
| 3.8     | Confirmation of Conformance               |                              |  |
| 4.1     | Requirements for Type Testing             |                              |  |
| 4.2     | Requirements for Routine Testing          |                              |  |
| 7       | Longevity                                 |                              |  |
| 8.1     | Technical Requirements                    |                              |  |
| 8.3     | Conductors                                |                              |  |
| 8.4     | Insulation                                |                              |  |
| 8.5     | Waveform Copper Wire Screen               |                              |  |
| 8.6     | Oversheath                                |                              |  |
| 8.7     | Identification                            |                              |  |



|           |                                |  |  |
|-----------|--------------------------------|--|--|
| <b>9</b>  | <b>Manufacturing</b>           |  |  |
| <b>10</b> | <b>Type Tests</b>              |  |  |
| <b>11</b> | <b>Logistical Requirements</b> |  |  |
| <b>12</b> | <b>Technical Support</b>       |  |  |
| <b>13</b> | <b>Samples</b>                 |  |  |
| <b>14</b> | <b>Cable Data Sheets</b>       |  |  |

Additional Comments :