

Electricity Specification 400C14

Issue 2 June 2023

132kV Cable Systems: Cable Accessories and Ancillary Equipment



Amendment Summary

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|--|--|
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1 Foreword

This Specification covers the technical requirements for various cable accessories and associated equipment for earthing and cross bonding to be used on 132kV underground circuits in the Electricity North West Limited (hereinafter referred to as ENWL) Distribution System.

2 Scope

This specification document covers the manufacture and supply of equipment for jointing and terminating cables used on ENWL network operating at 132kV ($U_m = 145kV$), specifically;

- Outdoor Cable Terminations
- Gas Immersed Cable Terminations
- Cable Joints for solid insulated (XLPE) cables
- Cable Joints for use on fluid filled (LPOF) cables
- Equipment for earthing and sheath bonding , including Link Boxes, Sheath Voltage Limiters and Conductors
- Control Systems for Oil filled Cables

The Supplier will be responsible for the design, manufacture, testing and delivery to site of approved 132kV Cable Accessories and associated earthing/bonding equipment.

Equipment based on this specification may be purchased as separate items, or they may be procured as part of a larger project including system design, installation, supply of cable, jointing works, civil or other electrical work packages.

This specification represents ENWL baseline specification for 132kV cable accessories which must be fully complied with, however where there is any specific project requirement which is in addition to, or deviates from the requirements of this document, then this shall be fully documented within the Tender documents for that project.

Jointing of 132kV cables is a key activity undertaken by ENWL and is carried out for a variety of reasons including the construction and extension of the Grid and Primary network, to allow for the diversion and re-positioning of existing cables and during repairs to existing systems.

Cable Accessories may be required for new systems using cables specified in ENWL specification document ES400C14, or they may be installed on existing XLPE solid insulated or paper insulated pressure assisted cables. It is important that before any supply of cable accessories, the supplier is satisfied the offered product is fully compatible with the cable construction and size for which it is intended. Wherever possible ENWL will provide full details of legacy cables in any project where jointing work is required on them.

All Equipment offered must be approved by the ENWL Circuits Policy Manager including the stated manufacturing location.

3 Definitions

| | |
|---|--|
| Approval | Sanction by the Electricity North West Underground Circuits Manager that specified criteria have been satisfied |
| Contract | 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. |
| Contractor | 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. |
| LPOF | Low Pressure Oil Filled (Cables) |
| GIS | Gas Insulated Switchgear |
| Maximum Voltage U_m | Maximum sustained power-frequency voltage between phase conductors, for which the cable is suitable |
| MDPE | Medium Density Polyethylene |
| Rated Voltage U | Nominal power-frequency voltage between phase conductors, for which the cable is suitable |
| Rated Voltage U_0 | Nominal power-frequency voltage between any conductor and earth for which the cable is suitable |
| Specification | The Specifications and schedules (if any) agreed by the parties for the purpose of the Contract. |
| Supplier | Any person or person's firm or company who supplies goods to Electricity North West or to its Contractor. |
| SPS | Site Pollution Severity |
| SVL | Sheath Voltage Limiter |
| Tender | An offer in writing to execute work or supply goods at a fixed price. |
| Tenderer | The person or person's firm or company, including personal representatives, successors and permitted assigns, invited by Electricity North West to submit a Tender. |
| XLPE | Cross-Linked Polyethylene. |

4 General Requirements for Approvals and Testing

4.1 Product not to be Changed

No change in the product, packaging or labelling shall be made after Approval has been granted without prior notice to the ENWL Circuits Policy Manager, and receipt of a written agreement to the proposed change from the ENWL Circuits Policy Manager.

4.2 ENWL Technical Approval

The Tenderer shall submit, with this Tender, proposals for testing which will demonstrate, to the satisfaction of the ENWL Circuits Policy Manager, compliance with this Specification. Such tests shall be carried out without expense to ENWL.

Alternatively, technical reports and other data may be submitted that the Tenderer considers will demonstrate, to the satisfaction of the ENWL Circuits Policy Manager, compliance with this Specification. Acceptance of this evidence shall be at the discretion of the ENWL Circuits Policy Manager but will not be unreasonably withheld.

Approval shall be 'factory specific' and is not transferable to another factory without the written Approval of the ENWL Circuits Policy Manager.

The Supplier and product shall comply with all the relevant requirements of ENWL document CP311.

4.3 Quality Assurance

The Tenderer shall confirm whether or not Approval is held in accordance with a quality assurance scheme accredited under ISO 9000. If not, the Tenderer shall submit a statement of the quality assurance procedures employed to control the quality of the product, including the performance of Suppliers and Sub-Contractors.

The right is reserved for the repeat of such tests, from time to time, that the ENWL Circuits Policy Manager may deem to be reasonably necessary to demonstrate continued compliance with the Specification.

The Tenderer shall submit, with the Tender, a list of tests and inspections which are carried out on the product prior to despatch which shall demonstrate, to the satisfaction of the ENWL Circuits Policy Manager, fitness for installation and service.

The Tenderer shall provide free of charge to ENWL such samples as may, in the opinion of the ENWL Circuits Policy Manager, be reasonably required for inspection and/or retention as quality control samples. The ENWL Circuits Policy Manager will confirm the requirement for samples at the time of Tendering.

The right is reserved for inspections to be made of Tenderer's facilities, from time to time, as deemed reasonably necessary by the ENWL Circuits Policy Manager to ensure compliance with this Specification and any Contract of which it forms a part.

The Tenderer shall submit, with the Tender, such details of product packaging disposal, as will enable ENWL to comply with the requirements of BS EN ISO 14001 - Environmental Management Systems.

4.4 Formulation

The Tenderer shall submit, with the Tender, such details of the formulation and use of the product and associated substances as will enable ENWL to comply with the obligations of the Health and Safety at Work Act 1974 and the Control of Substances Hazardous to Health Regulations 2002, in the use, storage and disposal of the product. The Tenderer may stipulate, prior to submission of such information, that it is to remain confidential, and the ENWL Circuits Policy Manager will, if requested, confirm agreement to this prior to receipt of the information.

4.5 Identification Markings

The Tenderer shall submit, with the Tender, details of markings which it is proposed to apply to the product or packaging to identify manufacturing batches or items. The forms and content of such markings shall be subject to the Approval of the ENWL Circuits Policy Manager and shall in all cases include the ENWL approved description and commodity code number.

The Tenderer shall submit, with the Tender, such details of marking gross weight on components, assemblies and packages, as will enable ENWL to comply with the Health and Safety Manual Handling Operation Regulations 1992, for components, assemblies and packages supplied with a gross weight over 1kg. The forms and content of such markings shall be subject to the Approval of the ENWL Circuits Policy Manager.

4.6 Minimum Life Expectancy

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

4.7 Product Conformity

Preference will be given to those Suppliers who can provide suitable product conformity certification to a recognised or specified standard, or an equivalent certification.

4.8 Confirmation of Conformance

The Tenderer shall complete the conformance declaration sheets in [Appendix A](#). Failure to complete these declaration sheets may result in an unacceptable bid.

4.9 Requirements for Type, Sample and Routine Testing

The testing requirements for each accessory type are given in [Section 8](#).

5 Operational Conditions

The following are general conditions of operation for 132kV cable systems are:

- Nominal system voltage $U_0/U (U_m)$: 76/132 (145)kV.
- Impulse withstand voltage : 650kV
- Nominal system frequency: 50Hz.
- 132kV Cable Systems shall be available for continuous operation at their stated design loading for 365 days a year, 24 hours per day. A service life of up to 60 years is expected.

- All assembled components forming part of a 132kV cable system shall be capable of operating under the normal and fault conditions as specified in the relevant cable specifications for that system.
- Joints and terminations shall be designed to cater for thermal and mechanical forces which will be developed during maximum three-phase symmetrical fault currents as specified in the relevant cable specifications for that system.
- Joints and terminations shall require no maintenance throughout their service life (excluding any routine inspections and surveys undertaken by ENWL)

6 Installation Conditions

132kV Cable Accessories specified in this document shall be installed in accordance with ENWL specification document ES400E5: Installation, Commissioning and Repair of Underground Cables Operating at 33kV and 132kV.

132kV Cable Joints may be surrounded by ground water for most of their operating lives. Joints may have to be installed in harsh environmental conditions such as flood plains, acidic soils or “Brown field” contaminated land.

132kV Outdoor Cable Terminations and ancillary earthing equipment can be expected to be subjected to the full range of climatic conditions encountered in the UK.

7 Technical Particulars

7.1 Compatibility

Accessories shall be suitable for use with cables with the following Specifications:

- (a) New single core 132kV Cables with XLPE Insulation to latest issue of ENWL specification ES400C14
- (b) Existing single core 132kV cables with XLPE insulation to previous versions of ES400C14
- (c) Existing single or three core Paper Insulated Impregnated Oil filled 132kV cables (LPOF), typically to ENA TS 09-04 or other legacy specifications.

ENWL current specification for XLPE insulated cables state a minimum thickness of insulation of 15mm, however, earlier designs of XLPE cables on the ENWL System could have an insulation thickness ranging from 22mm to 16mm. It may be required to joint old design to new design of cables.

As part of any offer, the Supplier shall satisfy themselves that the offered accessories are suitable for the cable design. ENWL will provide adequate details for any existing cables installed on the network to allow suppliers to match dimensionally critical components. The Supplier shall notify ENWL in writing if any doubts exist regarding the compatibility of accessories offered to be used on existing cables and propose mitigating actions to reduce delays during installation if alternative components are required.

All supplied components shall be compatible with all common mastics and tapes or other installation materials provided by the Tenderer. All components shall be compatible with ENWL approved cleaning wipes.

7.2 Reliability

Reliability is paramount. When any Tender for 132kV cable accessories is evaluated, preference will be given to proven established designs.

The Supplier shall demonstrate reliability for the offered design of the cable accessory by providing evidence of Type Test data and demonstrating a satisfactory service history.

7.3 132kV Outdoor XLPE Cable Terminations

Outdoor Terminations to comply with IEC 60840 and be a “dry” type design.

Outdoor termination insulators shall be of composite polymeric type conforming to IEC 60587. An alternating shed design is preferred. Porcelain insulators are not acceptable.

The minimum creepage distance of the insulator shall be 4495mm, corresponding to a Pollution Class rating of Type IV (according to IEC60815) / Type e (according to IEC60815-3).

132kV Outdoor Cable Terminations and ancillary equipment can be expected to be subjected to the full range of climatic conditions encountered in the UK. Ice coating may be assumed not to exceed 10mm and wind pressure may be assumed not to exceed 700Pa.

Outdoor terminations at 132kV shall be self-supporting by a plumbed or clamped baseplate. The baseplate shall be insulated from the surrounding steel support structure by stand-off insulators.

Co-ordinating Gaps (Arcing horns) shall be provided with a spacing of 1000mm.

The Tenderer shall provide details for the supporting steelwork structure mounting arrangements.

Sealing ends shall be equipped with a top bolt assembly, which is appropriate to the type of connection to be made to it.

7.4 132kV Gas Immersed XLPE Cable Terminations

Gas Insulated Switchgear terminations shall comply with the requirements of IEC 60840 and IEC 62271-209.

Dry type designs are preferred. They shall be designed to fit into the type of Gas Insulated Switchgear as specified in any Project Tender Document.

7.5 132kV Cable Joints for XLPE cables

The joint shall comply with the requirements of IEC 60840.

A cold applied joint body shall be provided with a conductive Faraday cage that shall be designed to cover and overlap the connector. The joint body shall also have geometric-stress cones which shall be designed to make contact with the cable semi-conducting screen at either end of the cable joint.

A “three piece” design with separate stress cones and main body is preferred to allow for cables of different insulation diameters to be jointed.

Connectors shall be mechanical only. Welded connections are not allowed.

Joints shall be available as both straight joint and screen sectionalising joint designs.

The Tenderer shall provide details of any special tooling required for installation. Preference will be given to designs that can be installed without requirement for long joint bays to accommodate pulling tools.

Joints may have to be installed and remain in environmental conditions such as flood plains, acidic soils or “Brown field” contaminated land and the outer protection shall be capable of maintaining the integrity of the joint in all circumstances. If specified in the project tender document, joints shall be offered with an increased level of outer protection against particularly harsh environmental conditions.

7.6 132kV Cable Joints for LPOF cables

This shall include oil filled straight joints and transition joints to connect to XLPE insulated cables.

Joints shall be tested to meet the requirements of ENA TS 09-4 and BS 7912. Additionally, this shall include the hydraulic, lightning impulse voltage and dielectric security tests specified in IEC 60141.

7.7 Link Housings

Cable Sheath Link Boxes shall be metal construction, manufactured and tested in accordance with ENA ER C55/6 and BS7912 Annex C.

Cable sheath link boxes shall be suitable for installation above ground on a gantry or tower or installed underground in a covered pit. Where boxes are to be buried they shall be installed in an appropriate pit, cover and frame assembly, which may or may not be supplied by the manufacture of the link box. Buried link boxes may be immersed in polluted water for the whole of their life and their design should be based on a service life of up to 60 years.

7.8 Sheath Voltage Limiters

SVLs shall meet the requirements of ENA ER C55/6 and BS 7912 Annex B.

Where the cable earthing and bonding arrangement dictates the use of SVLs, these shall be installed in an earthed metal-housed cable sheath link box as detailed in Section 7.7.

The SVLs may be supplied as single-phase or as a 3-phase unit. Where they are supplied as single-phase units they must be a “matched set” with identical characteristics.

7.9 Bonding Leads

Bonding leads shall conform to the requirements of ENA ER C55/6 and BS 7912 Annex A.

Earth bonding leads shall be appropriately sized for the required fault level of the cable system to which they are connected.

7.10 Control Systems for Oil filled Cables

Oil control systems shall be generally in accordance with clause 6 of ENA TS 09-4.

8 Testing

8.1 Type Tests on XLPE insulated Cable Accessories

A type test certificate, to the standards and tests specified in this document covering each accessory type for XLPE insulated cables, signed by the representative of a competent witnessing body, or a report by the manufacturer giving the results and signed by the appropriate personnel in his organisation shall be acceptable as evidence of type testing.

Cable Accessories shall be Type Tested as part of a Cable System as defined in IEC 60840, Clause 12. In addition, additional testing for Accessories as defined in IEC 60840, Clause 15 shall be carried out where relevant.

The following additional Type Tests are also required on outdoor terminations:

- Cantilever tests on termination insulators shall be carried out in accordance with the requirements of IEC 61462, Clause 8.5
- Salt Fog tests on termination insulators shall be carried out in accordance with the requirements of IEC 60507.
- Test methods for evaluating resistance to tracking and erosion and limits of acceptance in the requirements of IEC 60587.

The following additional Type Tests are also required on gas immersed terminations;

- Dielectric Tests on GIS terminations shall be carried out in accordance with the requirements of IEC 62 271-209.
- Cantilever Test on GIS terminations to meet requirements in BS7912, Clause 16: The connection shall be subjected to a bending moment of 4,500 N·m at its base, for not less than 1 minute at ambient temperature, without sustaining any damage.
- Gas Insulated Switchgear shall be fully tested with the same insulating gas to be used in the equipment.

8.2 Tests on LPOF Cable Accessories

Joints shall be Routine tested to meet the requirements of ENA TS 09-4, section 11. Additionally, this shall include the hydraulic, lightning impulse voltage and dielectric security tests specified in IEC 60141.

8.3 Tests on Earthing and Cross Bonding Accessories

All accessories for earthing and cross-bonding shall comply with the requirements of ENA ER C55/6 and ENA TS 41-24.

8.4 Factory Routine Testing

Tenderers shall submit details of their inspection test plans to include any factory routine tests carried out on all components that make up the complete accessories.

As a minimum, all components shall be visually inspected prior to despatch, however for critical items such as insulators or stress cones, then testing of each item for partial discharge and A.C voltage withstand shall be carried out and the test results recorded and supplied as part of the delivery documents.

8.5 On Site Testing

Cable Systems must be suitable for on-site tests as specified in CP319.

Accessories shall be suitably insulated to permit the application of on-site DC high voltage withstand tests to the oversheath of the cable, as specified in IEC 60229.

9 Packaging

Packaging of accessories shall be designed to protect against mechanical damage and the ingress of dirt and moisture.

For larger components, packaging that is capable of being stored outdoors shall be provided. All packaging and components shall be capable of being stored without deterioration within the temperature range $-10^{\circ}C$ to $+40^{\circ}C$ when protected from direct sunlight.

Weatherproof timber crates are preferred and shall use tensioned straps to secure lids. Nails shall not be used to fix down any removable lids.

Packaging shall have clear labels or icons depicting requirements for their storage, e.g. "this way up". Any packaging which is not suitable for storage outdoors shall be clearly marked as such.

Components with a shelf life shall have the final date of use prominently and indelibly displayed on the exterior packaging, and also on the immediate packaging of the component.

Packaging shall be labelled with a full description of the products, including any ENWL project or order references and the gross weight of the package. For critical components such as insulators and stress cones, packaging shall include a label or printing of unique serial or batch numbers which can be cross referenced to the routine test documentation.

10 Customer 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 accessories.

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

10.1 Installation Training

Installation of the accessories may be undertaken by the Supplier, by ENWL operatives or by a third-party contractor.

Accessories shall only be installed by personnel who have undertaken a suitable manufacturer accredited training course for the product to be installed.

The Tenderer shall provide details of training or product familiarisation courses available. The Tenderer shall include for any such training costs for ENWL personnel if it is requested in any specific project Tender documents. Any training costs for third party contractors shall not be included.

10.2 Assembly Instructions

The Supplier shall provide fully detailed step by step assembly instructions. These instructions shall clearly show all cable stripping dimensions, procedures and recommendations for jointing, etc. To supplement any written description and to aid understanding, where possible, drawings shall also be provided for each step. A hard copy of the latest version of the jointing instructions shall be included in each kit.

Examples of the assembly instructions shall be supplied with each Tender request, and also included in the final documentation pack provided upon delivery

11 Technical Information Required with Tender

| TECHNICAL INFORMATION REQUIRED WITH TENDER | UNITS |
|---|-------|
| Manufacturers Data sheet including section drawing for each cable accessory offered | |
| Manufacturers' Safety Data Sheets (if applicable) | |
| Evidence of reliability record | |
| Details of Quality Management system | |
| Details of support structure mounting dimensions for Outdoor Terminations | |
| Details of Customer Support | |
| Details of Manufacturers installation training | |
| Assembly Instructions | |
| Completed Appendix A – Compliance Schedule | |

12 Documents Referenced

| DOCUMENTS REFERENCED | |
|--|--|
| Health and Safety at Work Act 1974 | |
| Control of Substances Hazardous to Health Regulations 2002 | |
| Manual Handling Operations Regulations 1992 | |
| BS EN ISO 9000 | Quality Management Systems |
| BS EN ISO 14001 | Environmental Management Systems |
| IEC 60141-1 | Tests on oil-filled and gas-pressure cables and their accessories - Part 1: Oil-filled, paper or polypropylene paper laminate insulated, metal-sheathed cables and accessories for alternating voltages up to and including 500 kV |
| IEC 60229 | Electric Cables – Tests on Extruded Oversheaths with a special protective function. |
| IEC 60507 | Artificial Pollution test on high voltage insulator to be used on AC systems |
| IEC 60587 | Electrical insulating materials used under severe ambient conditions. Test methods for evaluating resistance to tracking and erosion. |
| IEC 60815 | Guide for the selection and dimensioning of high-voltage insulators for polluted conditions |
| IEC 60815-3 | Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 3: Polymer insulators for a.c. system |
| IEC 60840 | Power cables with extruded insulation and their accessories for rated voltages from 30 kV ($U_m = 36$ kV) up to 150 kV ($U_m = 170$ kV) – Test methods and requirements. |

| | |
|---|---|
| IEC 61462 | Composite hollow insulators – Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1 000 V |
| IEC 62271-209 | High-voltage switchgear and control gear Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV - Fluid-filled and extruded insulation cables - Fluid-filled and dry-type cable-terminations |
| BS 7912 | Power Cables with XLPE insulation and metal sheath, and their accessories, for rated voltages from 66kV (U_m 72.5kV) to 132kV (U_m 145kV). (Implementation of HD632) |
| Electricity Networks Association Engineering Recommendation ENA ER C55/6 | Insulated Sheath Power Cable Systems. |
| Electricity Networks Association Technical Specification ENA TS 09-04 | 66kV and 132kV Paper Insulated Impregnated Oil filled and Gas Pressure Type Cable Power Systems |
| Electricity Networks Association Technical Specification ENA TS 41-24 | Guidelines for the design, installation, testing and maintenance of main earthing systems in substations |
| ENWL Code of Practice CP311 | Equipment Approval Policy and Process |
| ENWL Code of Practice CP319 | Applied HV Tests |
| ENWL Specification ES400E5 | Installation, Commissioning and Repair of Underground Cables Operating at 33kV and 132kV |
| ENWL Specification ES400C14 | 132kV Cables with Extruded XLPE Insulation. |

13 Keywords

132kV; cable system, joint; jointing; termination; link box

Appendix A – 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:

| | |
|-------|--|
| N/A = | Clause is not applicable/appropriate to the product/service. |
| C1 = | The product/service conforms fully with the requirements of this clause. |
| C2 = | The product/service conforms partially with the requirements of this clause. |
| C3 = | The product/service does not conform to the requirements of this clause. |
| C4 = | 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 * (must be completed if code is not C1) |
|---------|---|------------------------------|--|
| 4.1 | Product not to be Changed | | |
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* Applicable specifications shall be stated in the Remarks column where alternatives are quoted within a section. The Remarks column shall also be used to indicate cases where the products or services exceed the quoted specifications.