WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

a nationalgrid company

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 82/3

Specification for Single Core 11kV and 33kV Cables

Author: **Richard Summers**

Implementation Date: **May 2022**

Approved by

Carl Ketley-Lowe
Engineering Policy Manager

Date: **11th May 2022**

Target Staff Group	**N/A**
Impact of Change	**Green – No major impact**
Planned Assurance checks	**N/A**

IMPLEMENTATION PLAN

Introduction

This document defines the 11kV and 33kV underground cables used within WPD and provides a standard with which the Purchasing section can tender.

Main Changes

The document has been updated to the most recent version of British Standards.

Impact of Changes

No major impact.

Implementation Actions

Immediate.

Implementation Timetable

This policy can be implemented with immediate effect.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
May 2022	• Updates to BS dates and minor clarifications.	Richard Summers
April 2020	• Document rewritten to include 11kV and 33kV XLPE and EPR cables.	Richard Summers
16/12/13	• This document has been updated to reflect the changes that have been made to the British Standard upon which this document is written.	Peter White

Contents

1.0 SCOPE

This Specification deals with Western Power Distribution (WPD's) requirements for cables suitable for use on an 11kV and 33kV, three phase, impedance earthed, 50 Hz underground distribution system.

The finished cable shall meet the latest requirements of BS 7870: Part 4.10, except where modified by this Specification and shall be insulated using either EPR or XLPE insulation.

2.0 VOLTAGE DESIGNATION

The minimum rated voltage U_o/U (U_m) as defined in BS 7870 Part 4.10, or equivalent standard, shall be 6.35/11 (12) kV and 19/33(36) kV

3.0 CONDUCTOR SIZES

Conductors shall be solid circular aluminium or stranded copper meeting the requirements of either BS EN 60228 or IEC 60228 or equivalent standard. The sizes required are shown below: -

Voltage	Solid Aluminium	Stranded Copper
11kV	95mm2	
	185mm^2	
	300mm^2	300mm^2
		400mm^2
		630mm^2
		800mm^2
33kV		185mm^2
		300mm^2
		400mm^2
		630mm^2
		800mm^2

Provision shall be made to prevent the longitudinal and radial transmission of water in the stranded copper conductor, using tape water blocking material.

4.0 INSULATION AND SCREENS

The insulation and the semi-conducting screens shall be applied as a continuous single pass triple extrusion, free of factory repairs.

The extruded conductor screen shall comply with the requirements of BS 7870, Part 4, clause 4.2.2, or equivalent standard; a semi-conducting tape is permitted between the conductor and conductor screen.

The thickness of the insulation shall conform to the specifications in Tables 1 in BS 7870 Part 4.10.

The maximum shrinkage of the insulation shall be 2% when measured in accordance with clause 7.3 of BS7870 part 4.10.

For concentricity, all cables shall meet the requirements of BS7870:4.10

The insulation shall be either ethylene-propylene rubber (EPR) or cross linked polyethylene (XLPE).

For EPR cables the insulation screen shall be an extruded layer of cold peeling semi conducting compound, meeting with the requirements of Clause 4.2.4 of BS 7870 Part 4.10, or equivalent standard. The insulation screen shall be nominally 1mm thick and shall not permit indentations of the copper wire screen to penetrate to the insulation. EPR insulation / screening shall also meet the requirements of Appendix A (this is performed instead of BS7870 4.10 clause 7.6).

For XLPE cables the conductor screen shall be fully bonded and comply with Clause 4.2.4 of BS 7870 Part 4.10. The cross linking process shall be “Dry Cured” with no water used during the process.

REMOVAL OF BI-PRODUCTS

Precautions should be taken to ensure that gaseous cross-linking by-products are adequately removed from the core prior to supply. Once the two semi-conducting layers and the insulation have been extruded, in a single pass, the completed cable shall be stored in such a manner as to remove the bi-products produced during the cable manufacture. For EPR cables this must be below a level of 1%. At **no time** is the cable to pass onto the next process of cable manufacture without the removal of the bi-products from the newly insulated core.

5.0 LONG TERM AGEING

Cables offered must have successfully completed long term aging test detailed in clause 8.3 0f BS 7870 part 4.10. The results and details of these tests must be provided as part of this tender. **This test shall be repeated every 100kM (core length) of cable supplied.**

6.0 METALLIC SCREEN AND MOISTURE BLOCKING

The metallic screen shall consist of a layer of copper wires applied spirally or in an 'SZ' configuration with a maximum gap between wires of 4mm. The minimum outside diameter of each screen wire shall be no less than 1.0mm with a minimum nominal CSA of 35mm^2. The maximum resistance shall comply with table 6 of BS7870

The wires forming the screen shall be equalised by either a lapped Copper tape or wire. The tape or wire shall have a minimum cross-sectional area of 0.75 mm^2.

The cross-sectional area of the screen shall be capable of carrying an earth fault current of 3kA for 3 seconds adiabatically.

Water blocking shall be provided at the screen wires so that the cable passes the moisture penetration test outlined in BS7870.

7.0 PHASE MARKER

A coloured phase marker shall be applied to each phase of the triplexed cables, see clause 12 of this specification, so that the individual phases of the cable can be identified. The phase marker tapes shall be coloured as follows: -

L1 = Brown.

L2 = Black.

L3 = Grey.

Alternative phase marking will be considered but must be approved by WPD.

8.0 SHEATH

Where the cable has a DMZ4 sheath it shall be subjected to a retraction test, as defined in BS EN 60811 and the **shrinkage shall not exceed 2%.**

11kV cables shall be coloured red and 33kV cables shall be black. The manufacturers shall supply supporting evidence that red coloured MDPE is not seriously degraded by sunlight. BS 7870-1 table B for materials DMP5

Where there is a requirement for LSOH cables, these shall be coloured orange.

A graphite coating is not required.

9.0 EMBOSSING/MARKING

Embossing/marking shall be in accordance with BS 7870 Part 4.10 clause 4.5, or equivalent standard. In addition the manufacturer shall add a unique number, which shall identify that particular cable to a batch that is tied into the quality assurance system of the company so that all materials can be traced in the production of the said cable. This unique number shall be indelibly applied to the oversheath.

The sheath shall be indelibly printed with numerical distance markers at one- (1) metre intervals.

Cables shall also be marked externally with the words “WPD”. This marking can be either printer or embossed.

The embossing/printing shall be clear and distinct.

Other forms of identification will be considered upon application to the Cable Policy Section of WPD.

10.0 SEALING OF CABLE ENDS

Before dispatch all cables shall be sealed to prevent the ingress of moisture as per BS 7870 part 4.10, clause 4.6. **Where heat shrink or cold shrink caps are used they shall be loaded with conductive copper grease to prevent inadvertent energisation of capped ends.**

11.0 LAYING UP IN TRIPLEX FORMATION

WPD purchase the majority of cable in triplexed formation. Triplex formation is required for the following conductor types:-

11kV 95mm^2 solid aluminium
11kV 185mm^2 solid aluminium
11kV 185mm^2 solid aluminium LSOH
11kV 300mm^2 solid aluminium
11kV 300mm^2 stranded copper
11kV 300mm^2 stranded copper LSOH
11kV 400mm^2 stranded copper
33kV 185mm^2 stranded copper

A coloured phase marker, as per clause 8 of this specification, shall be applied to each phase of the cable so that the individual phases of the triplexed cable can be identified.

The triplexed version of cables shall have a minimum drum length of 250m per drum unless otherwise agreed and shall have a minimum lay length of 1.75 ± 0.25m

12.0 SINGLE CORE CABLES

The cables required in single core formation are as follows:-

11kV 630mm^2 stranded copper
11kV 800mm^2 stranded copper
33kV 185mm^2 stranded copper
33kV 300mm^2 stranded copper
33kV 400mm^2 stranded copper
33kV 630mm^2 stranded copper
33kV 800mm^2 stranded copper

13.0 LENGTHS

It should be noted that the triplex cables shall be supplied in route length and not core length. Single core cable shall be supplied in core length.

WPD have two modes of supply for these cables: - Cable supplied to stores is required in drum lengths. Just in Time (JIT) cables can be ordered in any length greater than 50m, these lengths will be required to be delivered to our local depots or directly to site. Details of the JIT system are contained elsewhere in the tender documentation.

14.0 TESTS

Routine, Sample and Type Tests shall be conducted in accordance with BS 7870 Part 4.10. In addition EPR insulation / screening shall meet the requirements of Appendix A.

15.0 TECHNICAL AUDIT-ABILITY

To assist in the audit-ability of polymeric cables it is necessary that manufacturers provide information, which will enable WPD to check that the cables being supplied at any point in time during the contract are the same as those that were, proposed to be supplied at the time of tendering process. i.e. No compounds or processes have been changed, without prior approval from WPD. This information is required for all cable sizes and tenderers shall complete the Technical Particulars contained in Appendix B of this document.

APPENDIX A

The conductor and insulation screens must be bonded to the insulation with no traces of dissociation between them, see Fig. 1a. There shall be no detectable traces of any inclusions between the screen and the insulation, see Fig, 1b. The insulation material shall not have broken through the screen, see Fig.1c. Nor shall there be any penetration of the insulation by the screen material, see Fig. 1d.

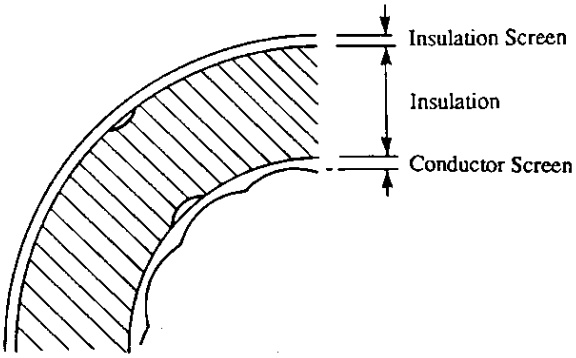

Fig. 1a

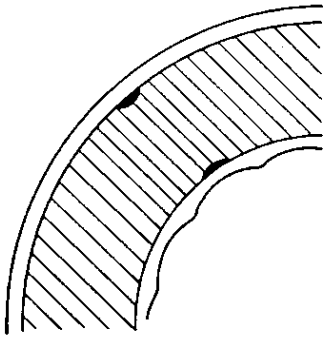

Fig. 1b

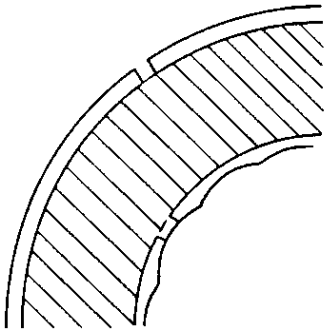

Fig. 1c

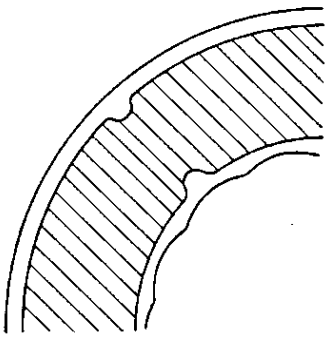

Fig. 1d

Fig. 1 Possible Defects in Extruded Insulation

APPENDIX A1

VOID AND CONTAMINANT DETERMINATION

Samples shall be prepared as follows: - Fifty millimetres of the sample shall be cut helically or in some other convenient manner to produce thin samples of the insulation and screens. The wafers shall be approximately 0.635mm thick. The cutting blade shall be sharp and shall produce a sample with uniform thickness and with very smooth cut surface. The sample shall be kept clean and shall be handled carefully to prevent scratching the cut surfaces.

The entire specimen shall be viewed by reflected light for general determination of freedom from voids and contaminants in the insulation and between the insulation and the screens.

1. A contaminant is any solid or liquid material, which is not inherent to EPR insulation.

2. The entire area of 20 consecutive wafers shall be examined with a minimum power of 15 magnifications.

3. A tabulation of numbers and sizes shall be made with a minimum power of 15 magnification of: -

    a. All voids, 0.0508mm in greatest dimension and larger

    b. All contaminants, 0.0508mm in greatest dimension and larger

This tabulation shall be recorded and reported to WPD

1. The largest void and the largest contaminant shall be marked by encircling and must be subsequently measured on a micrometre microscope.

2. The number of voids and contaminants per cubic cm (cm^3) of insulation shall be calculated from the tabulation. (The volume of the 20 wafers, or equivalent turns, may be determined by any convenient method.) If the 20 wafers constitute less than 1 cm^3 and if the void or contaminant count exceeds the allowable number, then a sufficient number of wafers from the sample shall be examined to total 1cm^3 of insulation.

The largest void and contaminant marked on the sample shall be measured with a micrometer microscope using a minimum of 40-power magnification. The largest dimension shall be measured only. If voids and contaminant exceed the limits in Appendix A3, the sample shall be considered to have failed to meet the test requirements.

The contact area between the insulation and the screen extrusions, both the conductor screen and the insulation screen, on the 20 wafers or equivalent turns shall be examined, using a minimum of 15-power magnification. The sample shall be considered to have failed to meet the test requirements if the contact surface between these extrusions and the insulation has protrusions or irregularities, which exceed the limits specified in Appendix A2.

The contact surface between semi conducting extrusions and the insulation shall be free from protrusions or irregularities, which extend from the cylindrical surface of the extrusion by more than 0.127mm towards the insulation or 0.254mm away from the insulation for the conductor screen, or ± 0.254mm for the insulation screen.

The insulation shall be a high quality, ozone resistant, ethylene propylene rubber. The colour of the insulating compound shall be in contrast to the colour of the semi conducting insulation screen so that any remaining particles can be readily seen if they remain on the surface of the insulation. The insulation of the completed cable shall be free from: -

1) Any void larger than 0.127mm.

2) Any contaminant larger than 0.254mm in its largest dimension. The number of contaminants of sizes between 0.0508mm and 0.254mm shall be recorded and reported for engineering information only.

The method of examination of sampling shall be in accordance with Appendix A1.

APPENDIX B

Technical Particulars for Tender Assessment

Single Core 11kV and 33kV Cables

Information to be supplied for **all** coductor sizes and designs

This schedule is to be completed by the Supplier to show the values, which can be guaranteed to apply to the size and design of cable, supplied.

No	Item	Value
1	Voltage designation (U_o/U (U_m)	kV
2	Nominal cross sectional area of conductor	mm^2
3	*Conductor details*	
	3.1 Material	
	3.2 Type of construction	
	3.3 Overall Diameter	mm
	3.4 Moisture blocking tape	
4	*Barrier tape under conductor screen*	
	4.1 Material	
	4.2 Nominal thickness (minimum average)	mm
5	*Extruded conductor screen*	
	5.1 Material	
	5.2 Nominal thickness (minimum average)	mm
	5.3 Minimum thickness	mm
	5.4 Nominal diameter over conductor screen	mm
	5.5 Thermal resistivity	^{0}Cm/W
	5.6 Nominal volume resistivity at 90^{0}C	Ω/m
6	*Maximum design dielectric stress at nominal voltage U_o*	
	6.1 At conductor screen (assumed smooth)	kV/mm
	6.2 At core screen	kV/mm
7	*Insulation*	
	7.1 Material	
	7.2 Maximum level of particle content	
	7.3 Nominal (minimum average) thickness of insulation between conductor screen and core screen	mm
	7.4 Minimum thickness	mm
	7.5 Thermal resistivity	^{0}Cm/W
8	*Extruded Insulation screen*	
	8.1 Material	
	8.2 Nominal thickness (minimum average)	mm
	8.3 Minimum thickness	mm
	8.4 Nominal diameter over screen	mm
	8.5 Thermal resistivity	^{0}Cm/W
	8.6 Nominal volume resistivity at 90^{0}C	Ω/m

No	Item	Value
9	*Extrusion process*	
	9.1 Type of extrusion line (catenary, vertical, etc.)	
	9.2 Disposition of extruders	
	9.3 Screening filter	
10	*Curing process*	
	10.1 Medium under which curing is carried out (dry nitrogen, silicone oil, etc.)	
	10.2 Curing temperature	^{0}C
	10.3 Curing Pressure	bar
11	*Cooling process*	
	11.1 Cooling medium (water, dry nitrogen, etc.)	
	11.2 Pressure	bar
12	*Heat treatment of cable core*	
	12.1 Manufacturing stage at which carried out	
	12.2 Heating method (current loading, vacuum, etc.)	
	12.3 Temperature	^{0}C
	12.4 Duration	hours
13	*Copper wire screen*	
	13.1 Number and diameter of wires	No/mm
	13.2 Number and thickness of equalizing tapes	No/mm
14	Nominal diameter over metallic screen	mm
15	*Oversheath*	
	15.1 Number of layers	
	15.2 Materials	
	15.3 Nominal thickness (minimum average)	mm
	15.4 Minimum thickness at any point	mm
	15.5 Nominal overall diameter of completed cable	mm
16	Nominal weight of completed cable	kg/m
17	*Minimum radius of bend round which cable can be laid:*	
	Maximum dc resistance of conductor at 20 ^{0}C	$\mu\Omega$/m
	Maximum ac resistance of conductor at 90 ^{0}C	$\mu\Omega$/m
	Equivalent star reactance of three phase circuit at 50Hz	$\mu\Omega$/m
	Maximum dc resistance of metallic screen/sheath of cable at 20^{0}C	$\mu\Omega$/m
	Maximum electrostatic capacity per core	ρF/m
	Maximum charging current per conductor per metre of cable at nominal voltage	mA/m

No	Item	Value
18	*Current carrying capacity:*	
	Winter continuous	A
	Summer continuous	A
19	*Installation and operating conditions on which current carrying capacities stated:*	
	Depth to cover	mm
	Details of sheath bonding	
	Summer ground ambient temperature	^{0}C
	Summer soil thermal resistivity	^{0}C m/W
	Winter ground ambient temperature	^{0}C
	Winter soil thermal resistivity	^{0}C m/W

APPENDIX C

SUPERSEDED DOCUMENTATION

This document supersedes EE SPEC: 82/2 dated April 2020 which has now been withdrawn.

APPENDIX D

RECORD OF COMMENT DURING CONSULTATION

No comments received

APPENDIX E

KEY WORDS

None.