

1. SCOPE

This document provides information and guidance on the application of polymeric cables on the SPEN 11kV network. Throughout this document, references to 11kV shall by inference also relate to 6kV and 6.6kV networks and equipment.

2. ISSUE RECORD

This is a Reference document. The current version is held on the EN Document Library.

It is your responsibility to ensure you work to the current version.

Issue Date	Issue No.	Author	Amendment Details
Aug 2003	1	D.W. Naylor	New Issue
Nov 2003	2	J. Livie	Issues Raised At Road Shows
Dec 2012	3	C Sherry	Significantly reduced in size because most of the previous information was about the transition period which finished a long time ago and most information is now referenced in new documents that have been created and are now referenced in this document.
Dec 2017	4	C Sherry	Reviewed and changed from a Controlled document to a Reference document in sections 2 and 4

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
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4. REVIEW

This is a Reference document which has a 10 year retention period after which a reminder will be issued to review and extend retention or archive.

DISTRIBUTION

This document is not part of a Manual maintained by Document Control and does not have a maintained distribution list.

5. CONTENTS

1. SCOPE	1
2. ISSUE RECORD	1
3. ISSUE AUTHORITY	1
4. REVIEW	1
DISTRIBUTION	1
5. CONTENTS	2
6. REFERENCE DOCUMENTS	3
7. POLICY	3
8. COMPONENTS AND STOCK CODES	6
9. CABLE RATINGS	6
9.1 Special Installation requirements to achieve the “Enhanced rating” for 300mm ² 3-core XLPE Cable.....	6
9.2 Background	6
9.3 Installation Method	7
9.4 Recording.....	7
10. PHOTOGRAPHS	8
11. INSTALLATION PARAMETERS	10
11.1 Bonding and Earthing.....	10
11.1.1 Feeder cables.....	10
11.1.2 Cables between switchgear and transformer.....	10
11.2 Temporary Bonding of Cable Screens.....	10
11.3 Insulation Testing of Polymeric Cables, and circuits comprising a mixture of cable types.....	10
12. SOLUTIONS FOR CONNECTIONS TO LEGACY SWITCHGEAR	11
13. OVERHEAD LINE TERMINATIONS	11

6. REFERENCE DOCUMENTS

CAB-06-001	Approved Equipment Register – Cables
CAB-17-001	Joint Kit Selector
CAB-15-003	Handling and Installation of Cables up to and Including 33kV
ESDD-02-007	Equipment Ratings and Assessment of EHV/HV Systems
SUB-02-613	Electrical Insulation Testing of HV Equipment up to 33kV

7. POLICY

SPEN policy is for the exclusive use of polymeric cables in new construction, diversion and repair works. Single core and three core polymeric cables shall be used in accordance with the policies outlined in this section. Connections to legacy switchgear and transformers may require different approaches – these are dealt with in later sections. Terminations onto switchgear and transformers shall use single core polymeric cables.

Main cable runs shall be laid using three core polymeric cables. This includes sections of cable inserted into existing lengths of pilc or picas cable for reasons such as fault repair or cable route deviation.

The transition between single core polymeric and three core cables shall be achieved by the use of trifurcating joints. These joints will also enable correct cable phasing to be achieved at switchgear and transformer terminations. Phasing will be achieved by crossing the single core cables before they enter the joint or cable box.

Terminations onto overhead lines shall normally be via three core polymeric cables. Single core cable overhead terminations are also permitted in accordance with the requirements of the next paragraph.

To avoid using two joints (a trifurcating joint and a straight joint) in close proximity on a short length of cable, **in the following situations only** it is permissible to lay three single core cables for the entire length of a cable connection:

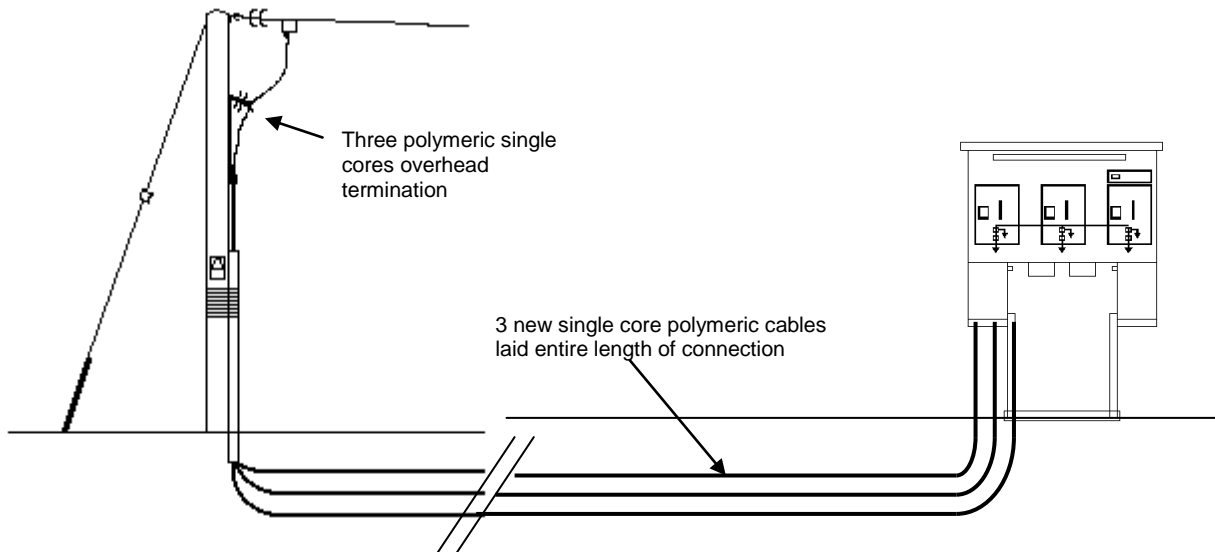
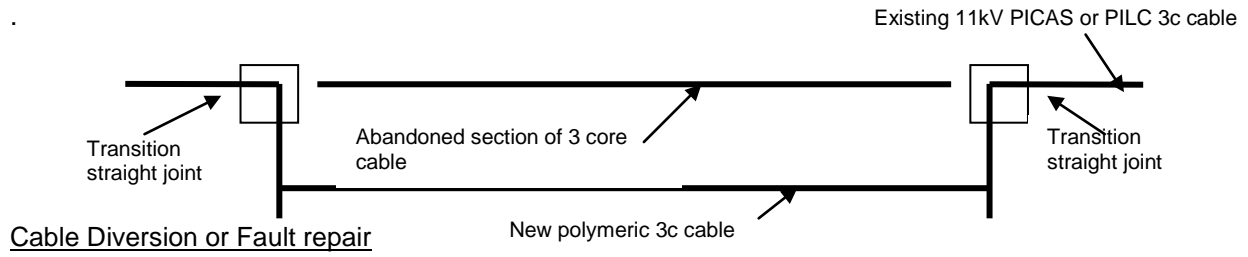
- cable less than 25m length between switchgear and overhead line
- cable less than 25m length between transformer and overhead line
- cable less than 25m length between switchgear and switchgear
- cable less than 25m length between switchgear and transformer
- cable less than 25m length between switchgear and cable section
- cable less than 25m length between cable section and overhead line

It should be noted that the 25m rule **does not apply** to 11kV single core runs between a Primary Transformer and the associated 11kV switchboard because it is not uncommon for these to be in excess of 25m. The earthing arrangements are also different.

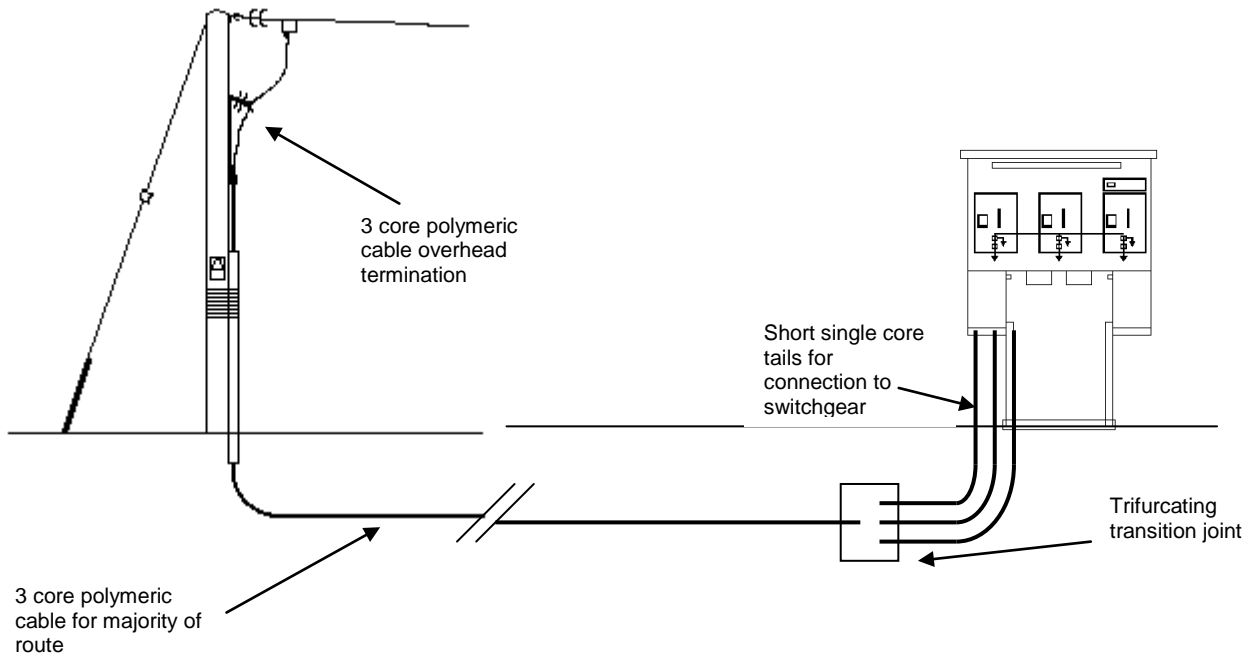
In all other situations, three-core cable shall be laid for the majority of the cable route connection with short lengths of single core cables being used for terminations as defined in the paragraphs above.

When laying single core cables, three cables shall always be laid – even if the application is only planned to be single phase.

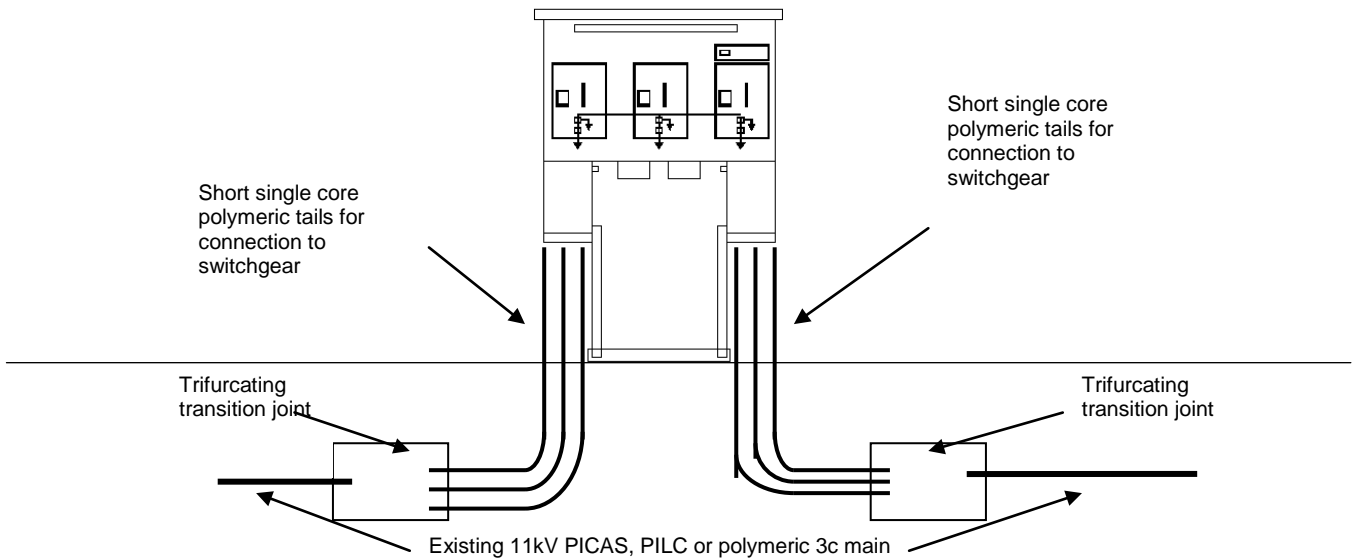
Examples of certain applications of this policy are shown on the following pages.



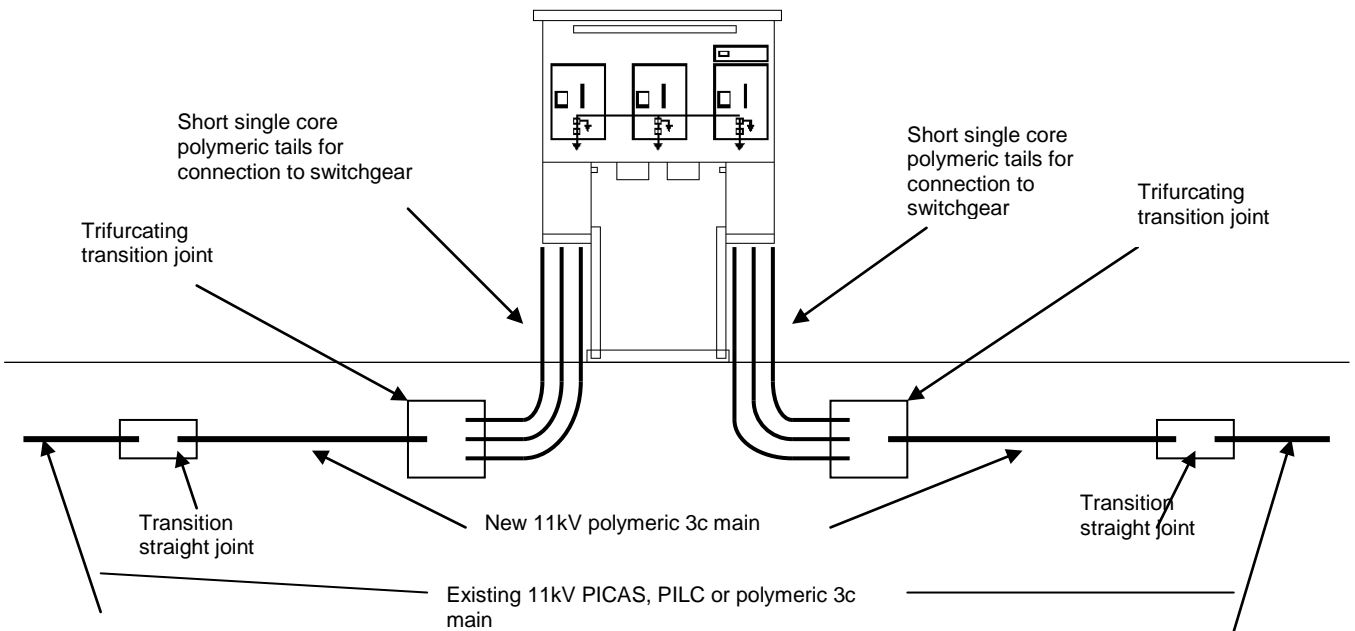
Cable connection between overhead line and switchgear (less than 25m length).



Cable connection between overhead line and switchgear (greater than 25m length).



New Substation to be connected (less than 25m from existing main).



New Substation to be connected (more than 25m from existing main).

8. COMPONENTS AND STOCK CODES

All SAP numbers for cables, cable terminations, joints and any associated modules are all contained in the Approved Equipment Register – Cables CAB-06-001. For specific joint or termination requirements to suit a range of different cables sizes refer to Joint Selector CAB-17-001.

The specialised stripping tools and consumable items required to work on polymeric cables are listed below along with their corresponding SAP numbers.

Tools	SAP Number
MDPE Sheath Stripper – KMS type	30982573
PG3 stripping pliers 26-52mm dia cables - 2.8mm cutting wheels	30982574
PG4 stripping pliers 45-75mm dia cables- 2.8mm cutting wheels	30982575
Spare blade for PG pliers - circular cut - blade 20C	30982576
Spare blade for PG pliers - longitudinal cut - blade 20L	30982577
LHM1R adjustable screen scoring tool 14-40mm dia cables (easy strip)	30982578
Spare blade for easy strip screen stripping tool LHM1R	30982302
FBS 1714-1 Fully bonded semi-con removing tool 10-50mm dia cables	30982299
Spare blade for Fully bonded screen stripping tool FBS 1714-1	30982300
BRMrd1 insulation removing tool c/w depth stop 14-40mm dia cables	30982580
Spare blade for XLPE insulation stripping tool BRMrd1	30982304
Adjustable torque wrench 1/2" drive (Norbar) 40-200Nm	30982589
11/33kV Temporary Continuity Connector (TCC)	30980307
2M diameter tape	30982273
Magnetic Clip Holding Tool	30026495
Consumables	
Chinagraph pencil	30983010
P60 grade oxide cloth 25mm x 25m (For abrading outersheath)	30981644
P240 grade oxide cloth 25mm x 25m (For smoothing & polishing insulation surface)	30908291
P320 grade oxide cloth 25mm x 25m (For smoothing & polishing insulation surface)	30980913
P400 grade oxide cloth 25mm x 25m (For smoothing & polishing insulation surface)	2360902
Silicone grease (For lubricating stripping tools only)	30982202
CES4 Heatshrink gland	30982065
CES5 Heatshrink gland	30982066

9. CABLE RATINGS

For cable ratings refer to ESDD-02-007 “Equipment Ratings and Assessment of EHV/HV Systems”

9.1 Special Installation requirements to achieve the “Enhanced rating” for 300mm² 3-core XLPE Cable

Ratings for 11kV XLPE cables are given in ESDD-02-007 “Equipment Ratings and Assessment of EHV/HV Systems”. The installation method described below allow an **enhanced rating** for 3-core 300mm² XLPE cable to be achieved by laying a continuous separate earth wire along with the cable.

9.2 Background

The SPEN assigned ratings for 3-core XLPE cables are limited by the company’s onerous system earth fault requirements. The maximum operating temperature of the phase conductors is limited to a lower than maximum value to allow the cable’s earth screen to start any fault carrying duty at a lower temperature. As a result, the theoretical maximum rating of the XLPE cable design is not achieved and by design under normal conditions, the ratings of the XLPE cable match those of the PICAS cables they replaced.

In some situations, the SPEN assigned rating for the 3-core 300mm² XLPE cable is slightly lower than customer requirements requiring a second cable to be laid to achieve a marginal increase in rating. The method described here allows a more cost effective approach whereby the cables earth screen is supplemented by a separate additional earth wire giving an improved earth fault capacity and enabling the power cable phase conductors to be operated at a higher temperature to achieve the enhanced rating given in ESDD-02-007.

Critical factors in utilising this method include:

- Use of appropriate earth cable.
- Secure installation method for supplementary earth cable (avoidance of accidental damage).
- Method of connection of supplementary earth cable into power cable joints at each joint position without compromising the joint's moisture seals.
- Recording of the "enhanced rating" installation so that the purpose and significance of the supplementary earth conductor is clear to any party consulting the cable records in future.

The enhanced rating given in ESDD 02 007 can only be achieved by rigorous application of the methods described here; the enhanced rating cannot be employed under any other circumstances.

9.3 Installation Method

- 1) The supplementary earth conductor shall be 32mm² copper (standard overhead line conductor).
- 2) The supplementary earth conductor shall be installed in a 32mm diameter duct to afford protection against 3rd party damage.
- 3) The duct containing the supplementary earth conductor shall be laid beside and touching the power cable or the power cable duct.
- 4) The duct containing the supplementary earth conductor shall be bound to the power cable or power cable duct every metre using appropriate plastic cable ties.
- 5) The supplementary earth conductor shall be connected to the power cable earth screen at every joint position using only the materials and jointing instructions provided with the joint kit.
- 6) Connections between the supplementary earth cable and the power cable earth screen shall be installed only by jointers who have been trained to make these connections.
- 7) The supplementary earth conductor shall be connected to the substation earth at both ends of the circuit.

9.4 Recording

Cable records shall be clearly and unambiguously marked to record:

- 1) That a supplementary earth conductor is installed adjacent to the power cable.
- 2) The enhanced **and** standard ratings for the circuit. The circuit shall revert to the standard rating should the supplementary earth conductor become damaged or disconnected.

10. PHOTOGRAPHS

The photos below show a selection of polymeric cables and terminations.



Single and three core polymeric cables



3 x single core overhead termination + earthing



3-core overhead termination + earthing



3 x single core switchgear termination. (L2 bushing boot left off for illustration purposes)

11. INSTALLATION PARAMETERS

For all installation parameters, configurations and ducted installation requirements refer to CAB-15-003.

11.1 Bonding and Earthing

11.1.1 Feeder cables

It is vital that the copper earth screen wires are bonded together and connected to the substation HV earth. The copper wires of each single core cable shall be gathered into individual brass shear bolt lugs. Most gland plates will incorporate a parking bar suitable for bolting the three lugs onto. A further fully rated connection is required from this parking bar to the substation HV earth. Gland plates shall be manufacture from a suitable non-ferrous material in order to eliminate eddy currents.

11.1.2 Cables between switchgear and transformer

Alternating current in single core cables results in voltages being induced in the cable sheaths, the magnitude of the induced voltage depends upon the cable length, current magnitude and spacing of conductors. It is possible to keep these voltages within tolerable limits by bonding and earthing at both ends, unfortunately this gives rise to circulating currents in the cable sheaths which has the effect of de-rating the cables. Accordingly it has been practice normally only to bond and earth the screens of single core cables between switchgear and transformer at one end – normally at the switchgear - typically up to 50m in length.

This practice has normally only been applied to the 11kV tails of Primary transformers (the only previous application of 11kV single core cables) which carry high currents.

For the application to connect cables between secondary switchgear and transformers the rating of the cable will remain adequate for the required duty. The copper screen wires shall be bonded and earthed at both the switchgear and transformer

11.2 Temporary Bonding of Cable Screens

A screen bonding kit has been approved that will be used to bond the screens of cables which are to be jointed. This has a series of screw fastenings that can be fitted to the bunched screen wires to keep them at the same potential during jointing.

11.3 Insulation Testing of Polymeric Cables, and circuits comprising a mixture of cable types

Cables shall be tested in accordance with the SPEN document SUB-02-613, Electrical Insulation Testing of HV Equipment up to 33kV.

12. SOLUTIONS FOR CONNECTIONS TO LEGACY SWITCHGEAR

Work has progressed to engineer solutions that will enable polymeric cables to be terminated in a wide range of older switchgear that currently utilise a compound filled box and a PICAS termination. A variety of Guroflex resin filled terminations are now available for both 3-core and single core cable applications. These Guroflex kits and associated modules can be referenced in CAB-06-001 and CAB-17-001. However it is important to remember that not all legacy cable boxes are suitable. Clearance measurements from phase to phase and phase to earth must be able to be maintained. Some older sharp edged connections do not have the correct geometry for Guroflex to be effective. For example some 6.6kV boxes being used at 11kV will not have sufficient clearances and smooth enough geometry for a Guroflex termination solution to be a viable option. Also the pouring holes in some legacy switchgear cable boxes are quite small and not suitable for Guroflex which is more viscous than hot bitumen compound or G38 oil. Attempting to pour Guroflex into these unsuitable boxes which will create air voids and increased electrical stresses shall be avoided.

13. OVERHEAD LINE TERMINATIONS

Two terminations will be available – for one three core cable, or three single core cables. The choice of which termination to use depends upon the policy outlined in an earlier section of this guide.

Many of the components are common between the terminations including the crucifix and surge diverter / insulators. Different cable cleats are required when used with single cores, which are specially shaped to hold the cores. Standard cable guards are still appropriate for use with polymeric cables, despite outer diameters being slightly different.