ScottishPower Distribution Cables & Equipment

Metal Theft

April 2012

SCOTTISHPOWER

As an aid to deterring to metal theft this booklet has been put together to help identify the types of utility power cables and associated underground equipment stolen from the ScottishPower network.

Contents

Abbreviations used in booklet

Al	Aluminium
BS	British Standard
CNE	Combined Neutral Earth
CSA	Cross Sectional Area (mm^2)
Cu	Copper
H	Hochstadter - screened 33kV paper cable
HSL	Hochstadter - screened separately lead sheathed 33kV paper cable
kV	kilo-volt
LSOH	Low Smoke Zero Halogen
LV	Low Voltage
MDPE	Medium Density PolyEthylene
PICAS	Paper Insulated Corrugated Aluminium Sheath
PILCSTA	Paper Insulated Lead Covered Steel Tape Armoured
PILCSWA	Paper Insulated Lead Covered Steel Wire Armoured
PVC	Polyvinyl Chloride
SNE	Separate Neutral Earth
XLPE	Cross Linked PolyEthylene

N.B.
All cable measurements given as an aide to identification are nominal sizes taken from British Standards or supplier specifications, actual cable sizes will vary slightly depending on the manufacturer and material quality.

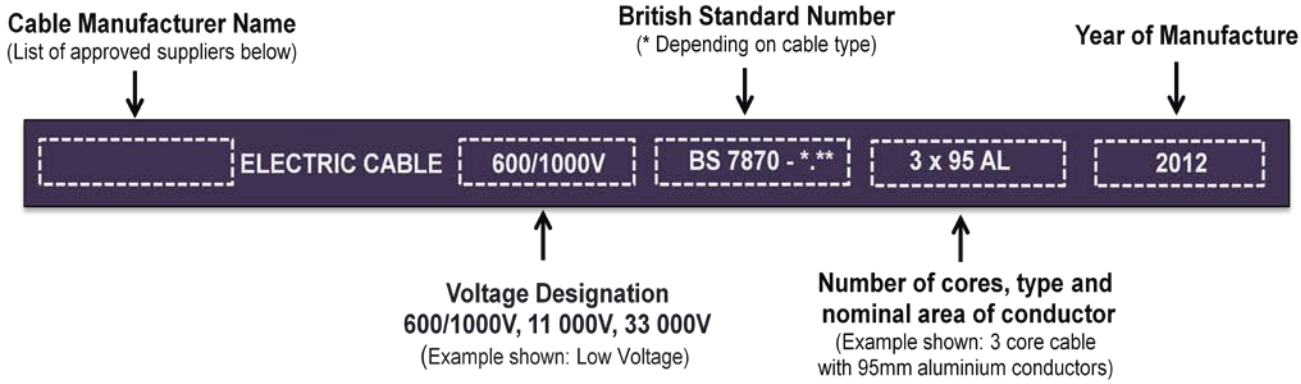
Identification

To assist in identifying cable types and equipment the booklet is laid out in sections covering:

- How to identify cable types from their external markings.
- Depth LV, 11kV & 33kV cables are buried in the ground.
- Types of identification / warning marker tapes placed over cables.
- Range of LV, 11kV & 33kV cables currently being installed on the network, and previous versions used.
- Earth wire & tapes
- Associated equipment – Substation LV distribution board, transformer winding.

External Markings

All cables with a plastic covering (oversheath) will have the information below embossed or indented onto it for identification purposes.



ScottishPower' current list of "approved manufacturers" for the supply of power cables up to and including 33kV:

- Copper Cable Company
- Ericsson
- Nexans
- NKT
- Prysmian
- Cabelte

Cable Identification

Depth of Cover

Cables and ducts (pipes containing cables) shall be installed so as to provide the minimum depth of cover. Standard depths for each voltage category in the footway are highlighted below.

Surface Type	Voltage		
	33kV	11kv	Low Voltage
	Minimum Depth of Cover (mm)		
Unmade ground, footways & footpaths	775	600	450
Roads	775	700	600
Cultivated ground inc. gardens	775	700	600
Agricultural land	910	910	910

Protective Tiles / Warning Tapes

The following tapes and tiles are installed over cables and ducted installations, with the high visibility colours providing a warning of danger when excavating.

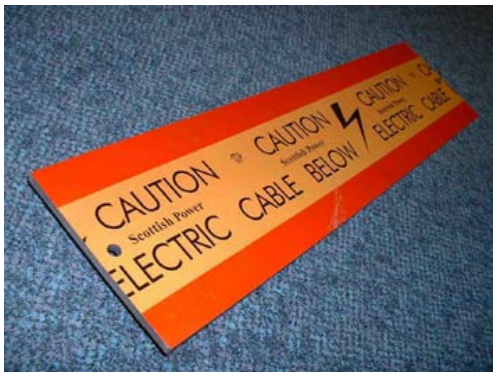
LV Tape

Thin polythene marker tape
0.1mm thick, 150mm wide

11kV Tape

Marker tape laminated onto polyethylene
2.5mm thick, 200mm wide

Cable Identification



33kV Tile

Thick tiles supplied with a plastic pin interlocking system
1000mm long x 244mm wide x 12mm thick

Older Design Protective Tiles

Before the use of plastic warning tape & tiles the brick versions below where used, for covering cables.

LV - Small tiles (230 x 110 x 50mm) linked together with U-shaped metal pins.
11kV - Large tile (325 x 195 x 60mm) with inter-linking design built in.
33kV - (not shown) Large concrete tiles, approx 1 metre in length.

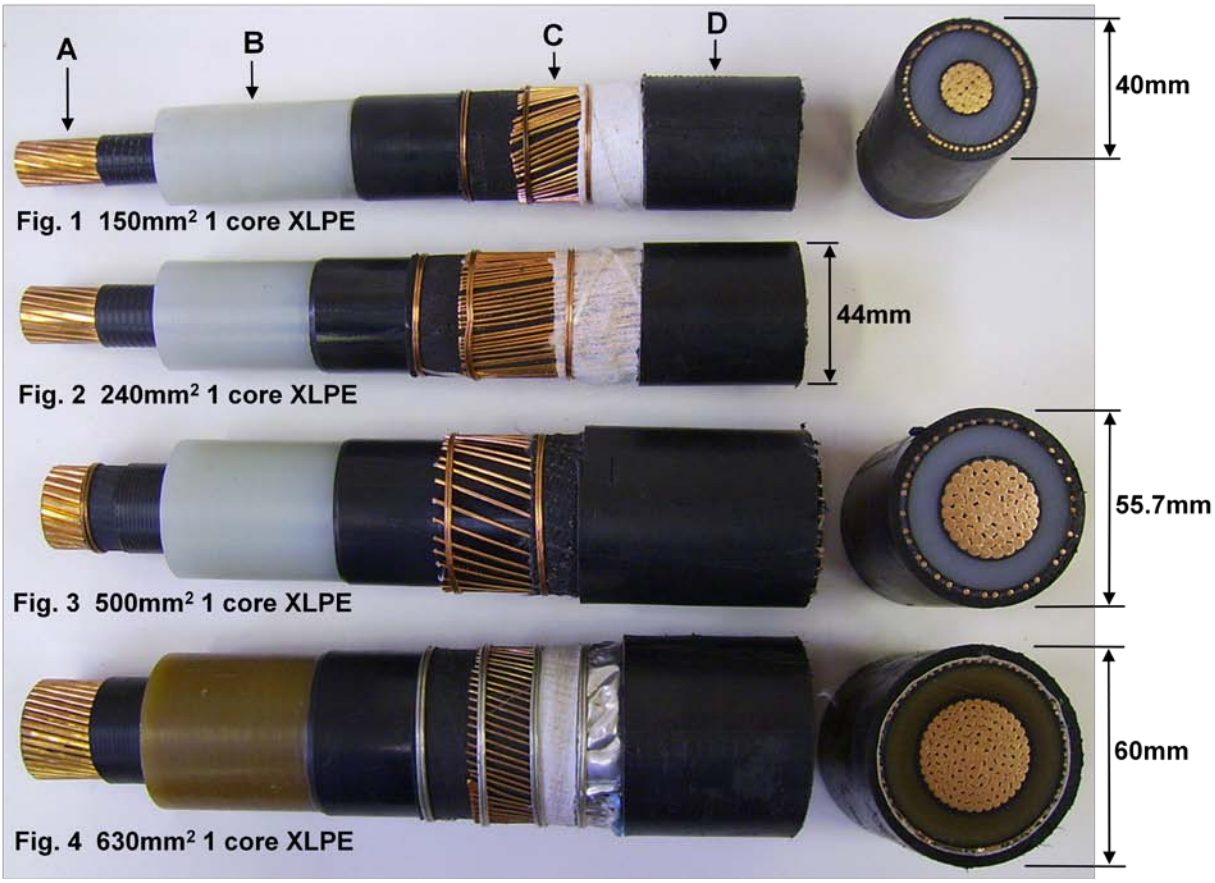
ScottishPower 33,000 Volt Cables

Single Core Copper XLPE Cable

The single core XLPE cable shown below in fig.1 was used as the standard circuit cable for 33kV up until March 2011. It is still available for repairs or deviations to existing Cu. cables, but has now been replaced by an aluminium version.
The cables in figs. 2,3 & 4 are used on windfarm and connection from the grid applications.
All single core 33 & 11kV cables should be laid in touching trefoil (triangular) formation and tied together.

Cable Construction

A. Copper conductor – stranded round, range available shown in figs.1,2,3,4.
   Recently a 800mm^2 version of this cable has been installed on a windfarm job in Scotland.
B. XLPE insulation – thickness 8mm
C. Copper wire earth screen - 50mm^2 CSA on all sizes of cable
D. MDPE oversheath



ScottishPower 33,000 Volt Cables

Single Core Aluminium XLPE Cable

Aluminium single core XLPE cables are now used as the standard circuit cables for 33kV, as from March 2011.
The introduction of these aluminium cables was due to the large rise in copper prices in recent years, even taking into account the larger conductor sizes required to carry the same power.

- 240mm^2 Al replacing 150mm^2 Cu
- 400mm^2 AL replacing 240mm^2 Cu

Cable Construction

A. Aluminium conductor – stranded round, range 240 & 400mm^2
B. XLPE insulation – thickness 8mm
C. Copper wire earth screen - 50mm^2 CSA on all sizes of cable
D. MDPE oversheath

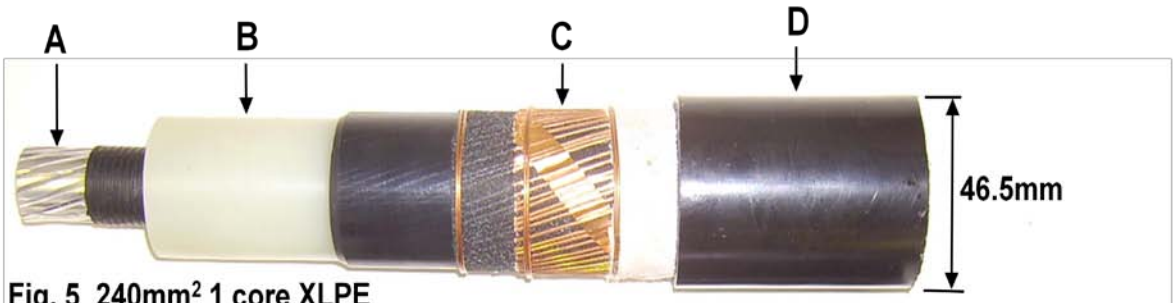


Fig. 5 240mm^2 1 core XLPE

Fig. 6 400mm^2 1 core XLPE

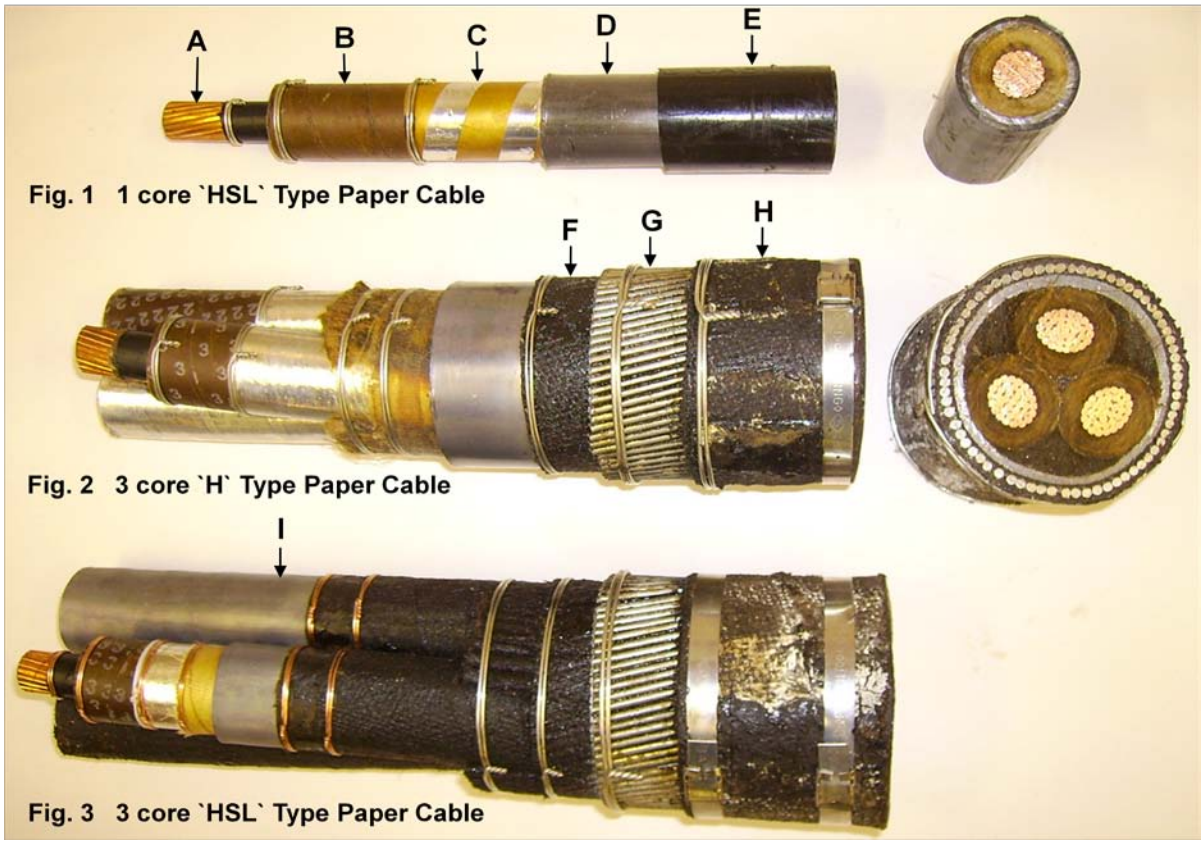
ScottishPower 33,000 Volt Cables

Paper Insulated Lead Covered 33kV Cables

Fig. 1 – Single core cable was generally used for switchgear connections within large substation sites.
Fig. 2 - This cable was the main 33kV circuit cable installed on the network up to the mid 1990's, prior to the introduction of XLPE cables. The standard conductor size used was 185mm.
Fig.3 – 3 core HSL cable was installed in short sections for connections up poles to overhead lines.

Cable Construction

A. Copper or aluminium conductors
   - 3 core range of conductor sizes on the network 70-300mm^2 with a diameter range between 80.9 – 107.2mm
B. Layers of paper insulation impregnated with mineral oil compound – thickness 6.8mm
C. Conductive layer on each core - insulation screening
D. Lead sheath with bitumen coating
E. PVC oversheath
F. Bitumen coated paper and hessian bedding layers
G. Steel wire armours
H. Bitumen coated hessian tape serving (oversheath)
I. Separate lead sheath around each core, on 3 core HSL cable



ScottishPower 11,000 Volt Cables

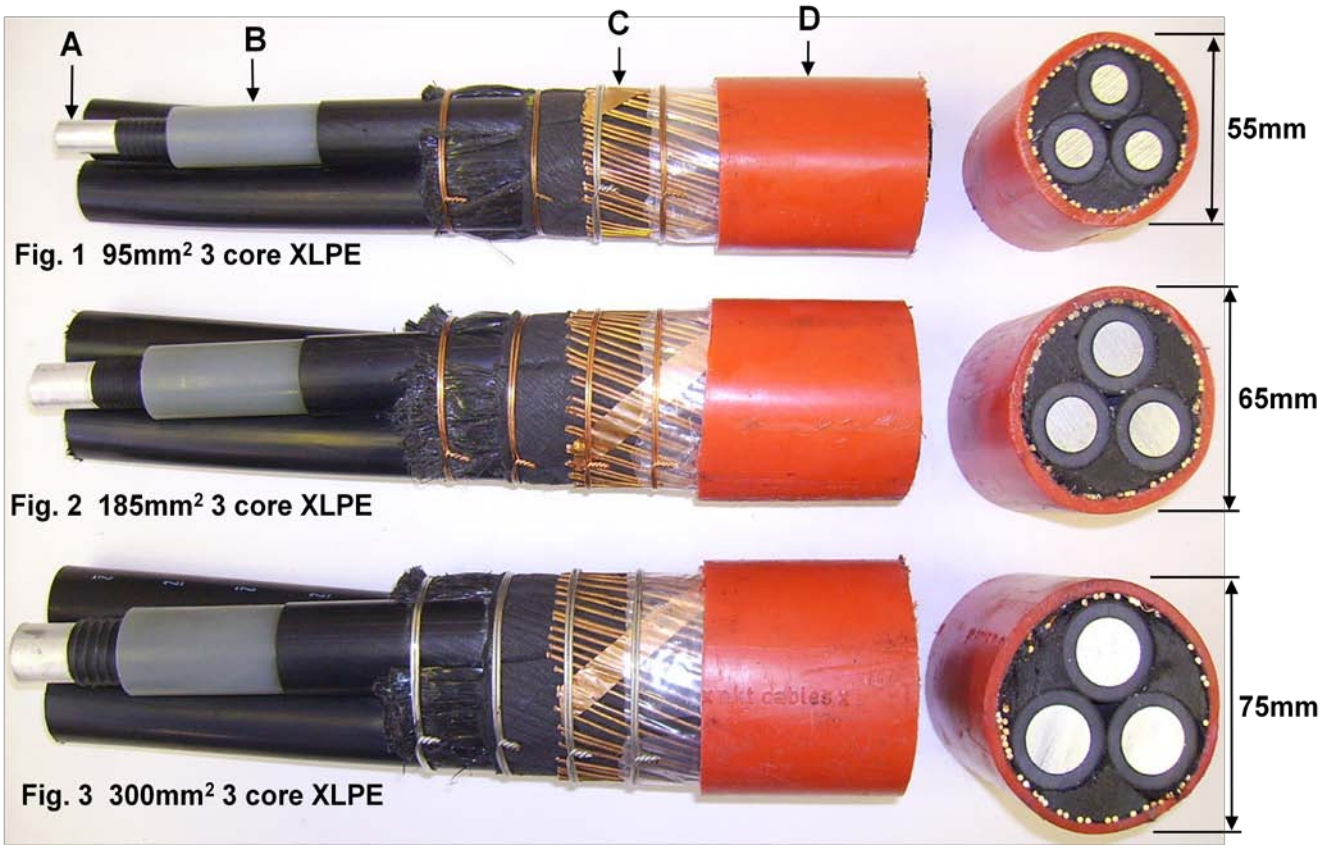
Three Core XLPE Cable

ScottishPower began installing this type of cable in October 2003, as a replacement for PICAS, paper insulated cable.

The three core XLPE cable shown below is currently used as the standard underground circuit cable on the 11kV network.
It can also be found connected to terminations on overhead line poles.

Cable Construction

A. Aluminium conductors – 3 x 95, 185, 300mm^2 solid round
B. XLPE insulation – thickness 3.4mm on each core
C. Copper wire earth screen
   - Fig.1 - 70mm^2 CSA on 95mm^2 cable
   - Figs. 2 & 3 - 95mm^2 CSA on 185 & 300mm^2 cables
D. Red MDPE oversheath



ScottishPower 11,000 Volt Cables

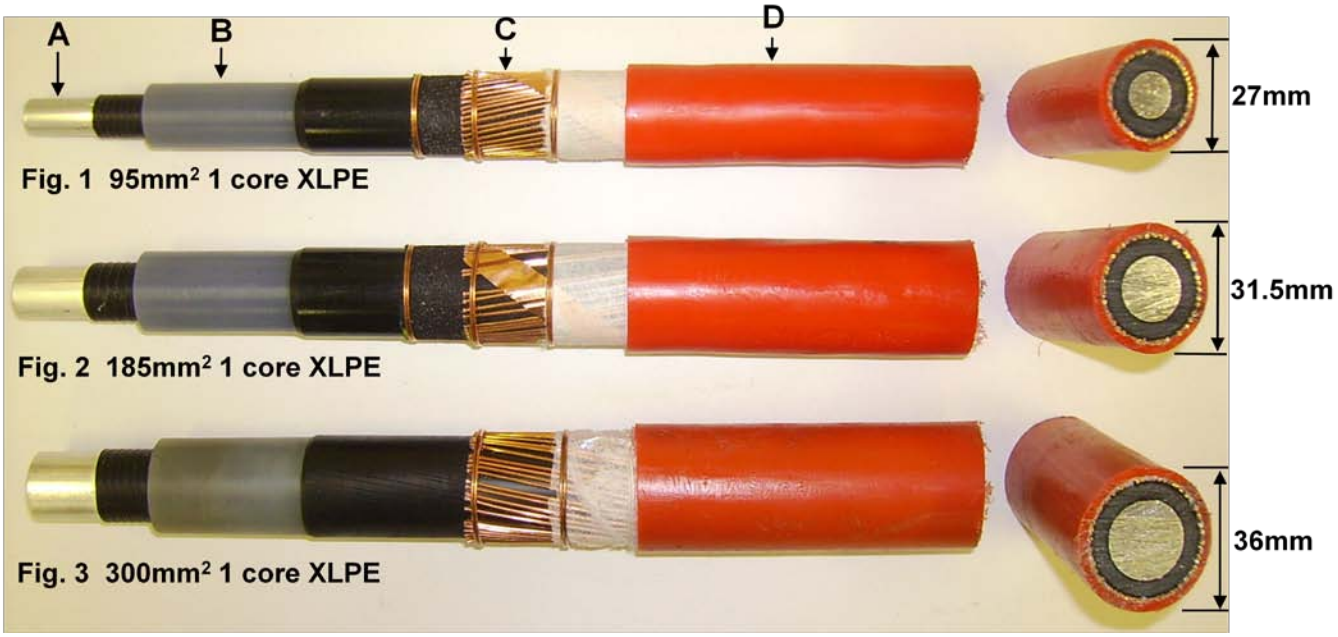
Single Core XLPE Cable

ScottishPower began installing this type of cable in October 2003.

The single core XLPE cable shown below is only used within 25 metres of a substation, for connections to switchgear or pole terminations.

Cable Construction

A. Aluminium conductor – 95, 185, 300mm^2 solid round
B. XLPE insulation – thickness 3.4mm
C. Copper wire earth screen - 35mm^2 CSA on all 3 sizes of cable
D. Red MDPE oversheath



ScottishPower 11,000 Volt Cables

Single Core XLPE Cable

The single core XLPE cables shown below figs.1 & 2 are used for connections between transformers and switchgear at primary substation sites.

Cable Construction

A. Copper conductor – stranded round 300 & 500mm^2
B. XLPE insulation – thickness 3.4mm
C. Copper wire earth screen - 35mm^2 CSA on both sizes of cable
D. Red MDPE oversheath

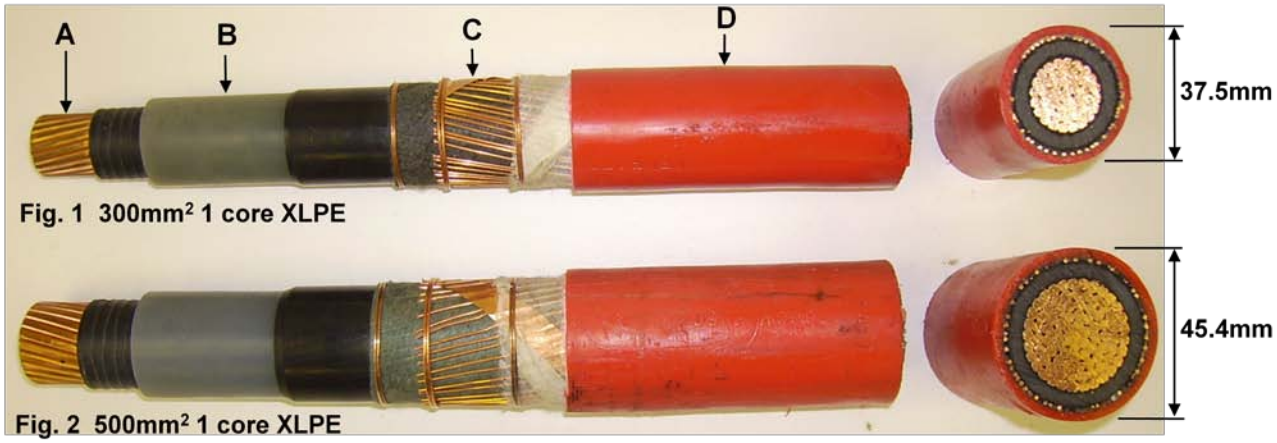


Fig. 1 300mm^2 1 core XLPE

Fig. 2 500mm^2 1 core XLPE

Figs 3 & 4 show an older Paper Insulated Lead Covered (PILC) cable used for the same application.

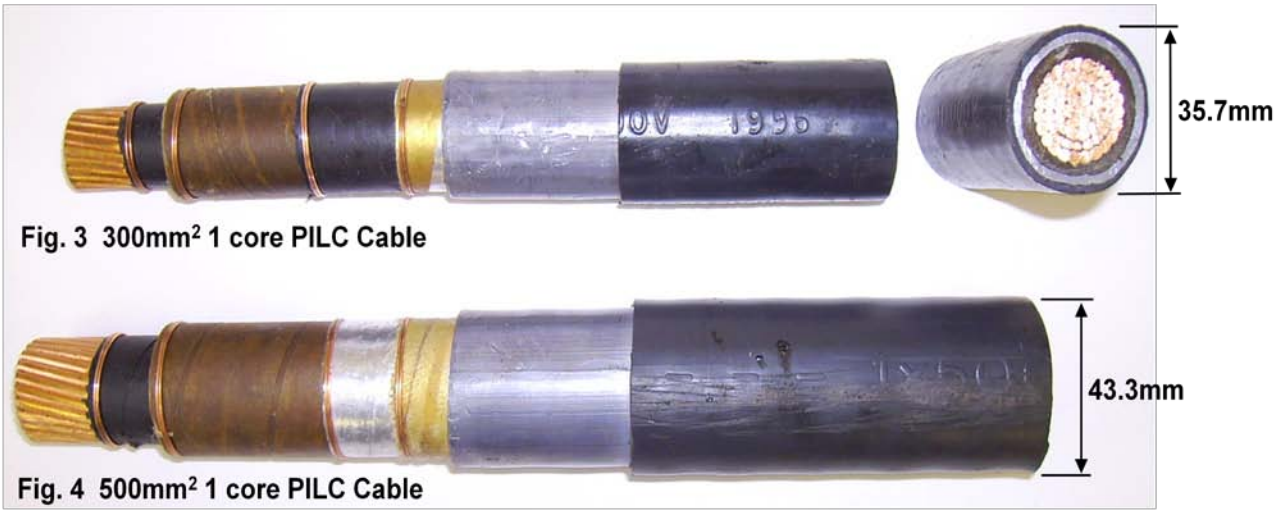


Fig. 3 300mm^2 1 core PILC Cable

Fig. 4 500mm^2 1 core PILC Cable

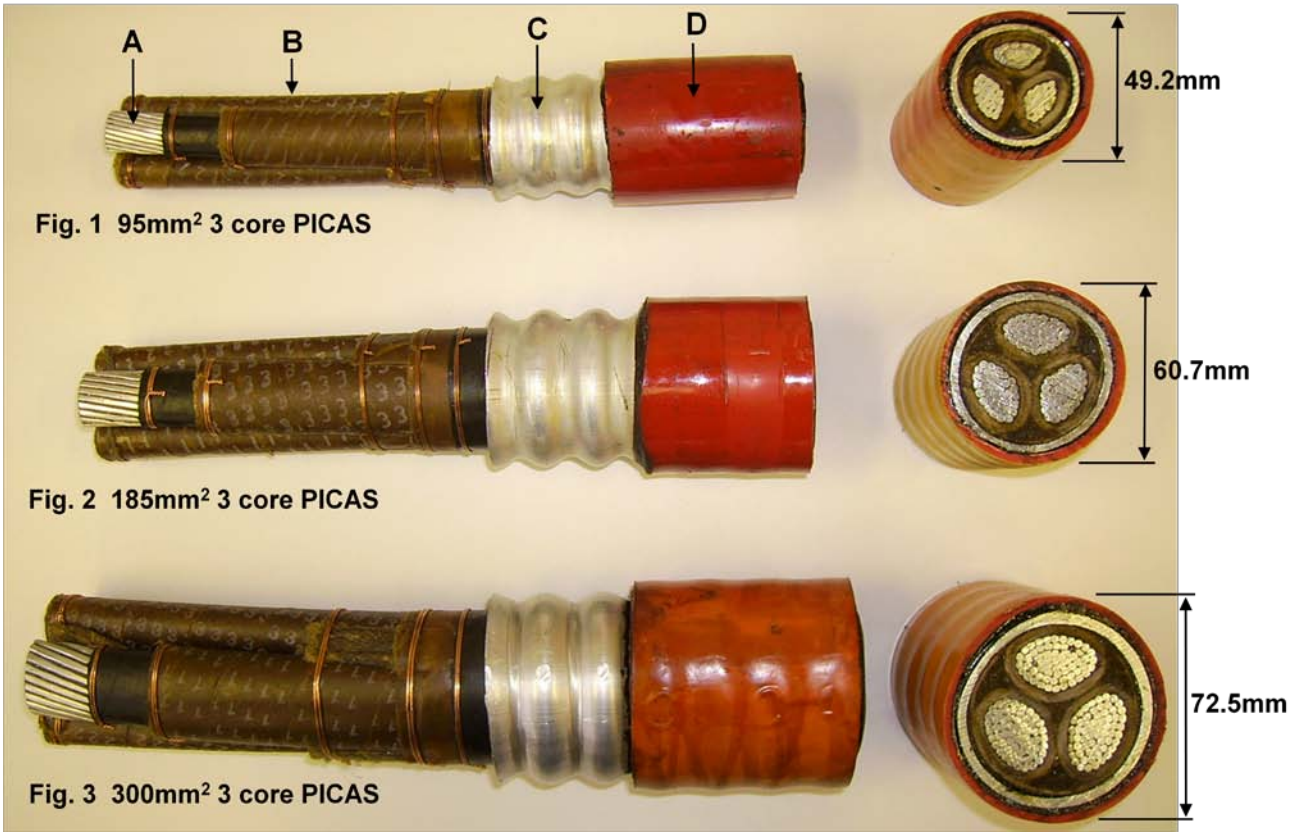
ScottishPower 11,000 Volt Cables

Paper Insulated Corrugated Aluminium Sheath (PICAS)

PICAS cable was installed on the 11kV network up to October 2003, when it was replaced by 3 core XLPE as the standard circuit cable.

Cable Construction

A. Aluminium conductor – 3 x stranded sector shaped, range available in figs1,2 & 3
B. Layers of paper insulation impregnated with mineral oil compound – thickness 3.4mm between conductor and sheath
C. Corrugated Aluminium sheath (bitumen coated)
D. Red PVC oversheath



ScottishPower 11,000 Volt Cables

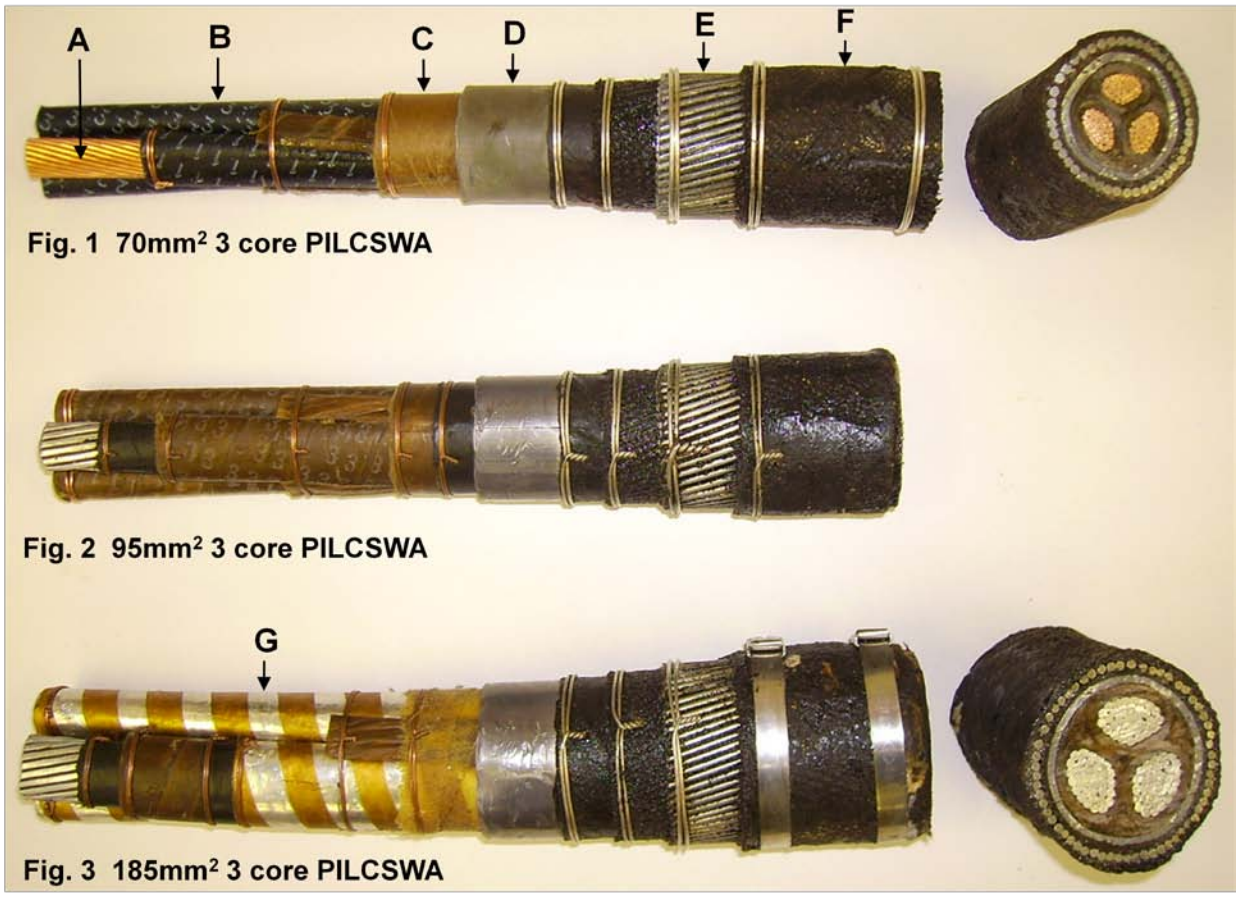
Paper Insulated Lead Covered Steel Wire Armoured (PILCSWA)

This was the main 11kV circuit cable installed on the network up to the early 1980's, prior to the introduction of PICAS cable.

Cable Construction

A. Aluminium or Copper conductors – 3 x stranded sector shaped on 70mm^2 cable and above, round conductors below 70mm^2.
   - Large range of conductor sizes on the network 16-300mm^2 with an overall diameter range between 40.3 - 71.6mm

B. Layers of paper insulation impregnated with mineral oil compound
C. Figs. 1 & 2 Additional (belt) insulation layer
D. Lead sheath, covered with bitumen coated paper and hessian layers, as a bedding for the armour wires
E. Steel wire armours
F. Bitumen coated hessian tape serving (oversheath)
G. Fig 3. Shows a screened cable with a conductive layer applied over each core.



ScottishPower Low Voltage Cables

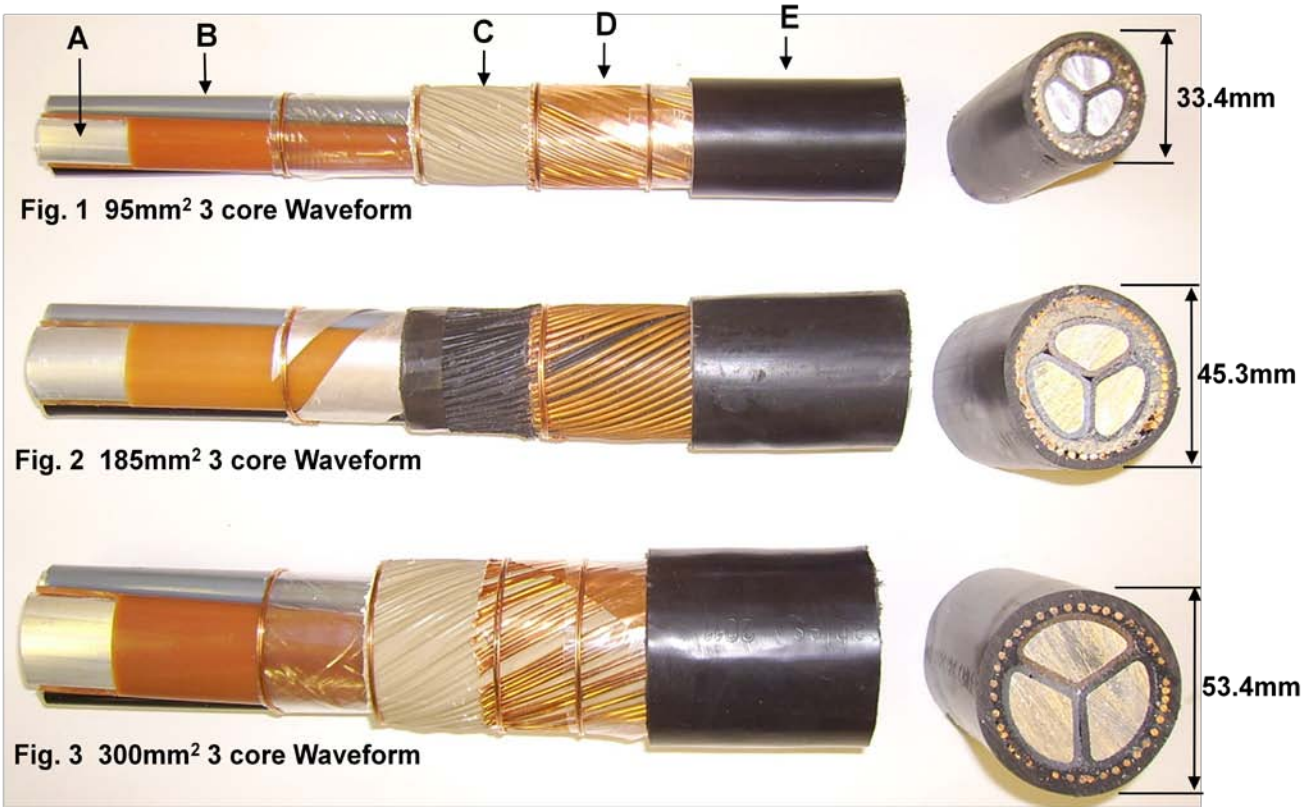
3 Core Waveform CNE Mains Cable

This is the standard low voltage cable used to construct all new extensions to the network.

The term waveform refers to the neutral/earth wires (D) in the cable which are laid in a wave formation (not wrapped around the cable) to assist stripping, when accessing the live conductors inside.

Cable Construction

A. Aluminium conductor – 3 x solid sector shaped, range available shown in figs. 1,2,3
B. XLPE insulation – thickness 95mm^2 cable = 1.1mm, 185 mm^2 cable = 1.6mm, 300 mm^2 cable = 1.8mm
    - Live cores coloured: Brown, Black, Grey
C. Rubber bedding layer
D. Copper neutral / earth wires
    - 70mm^2 CSA on 95mm^2 cable, fig.1
    - 120mm^2 CSA on 185 & 300mm^2 cable, figs.2 & 3
E. PVC oversheath



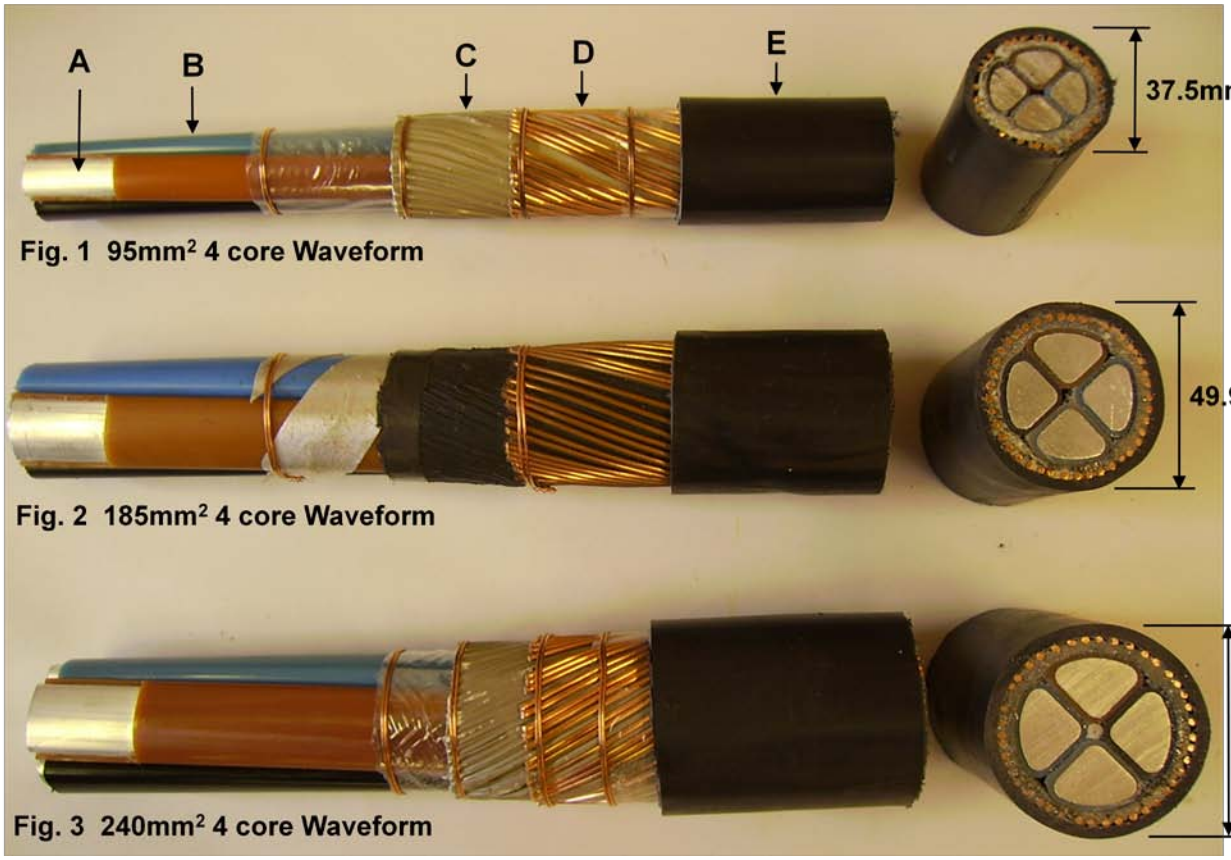
ScottishPower Low Voltage Cables

4 Core Waveform SNE Mains Cable

Use of this cable type on the network is limited to repairs and deviations on existing PILC LV cable.

Cable Construction

A. Aluminium conductor – 4 x solid sector shaped, range available shown in figs. 1,2,3
B. XLPE insulation – thickness 95 mm^2 cable = 1.1mm, 185 mm^2 cable = 1.6mm, 240mm^2 cable = 1.7mm
    - Live cores coloured: Brown, Black, Grey. Neutral: core Blue
C. Rubber bedding layer
D. Copper earth wires
    - 70mm^2 CSA on 95mm^2 cable, fig.1
    - 120mm^2 CSA on 185 & 240mm^2 cables, figs.2 & 3
E. PVC oversheath



ScottishPower Low Voltage Cables

Older Examples of Waveform CNE Mains Cable

The picture below shows previous colours used to identify the conductors of low voltage cables, and the new colours which came into force in March 2006 as part of harmonisation across Europe.

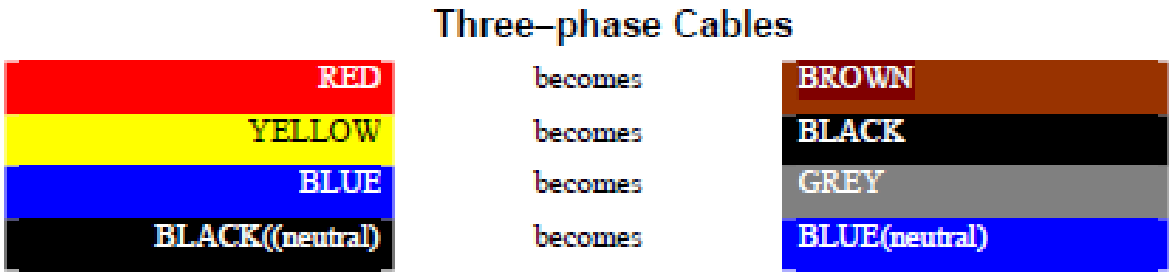
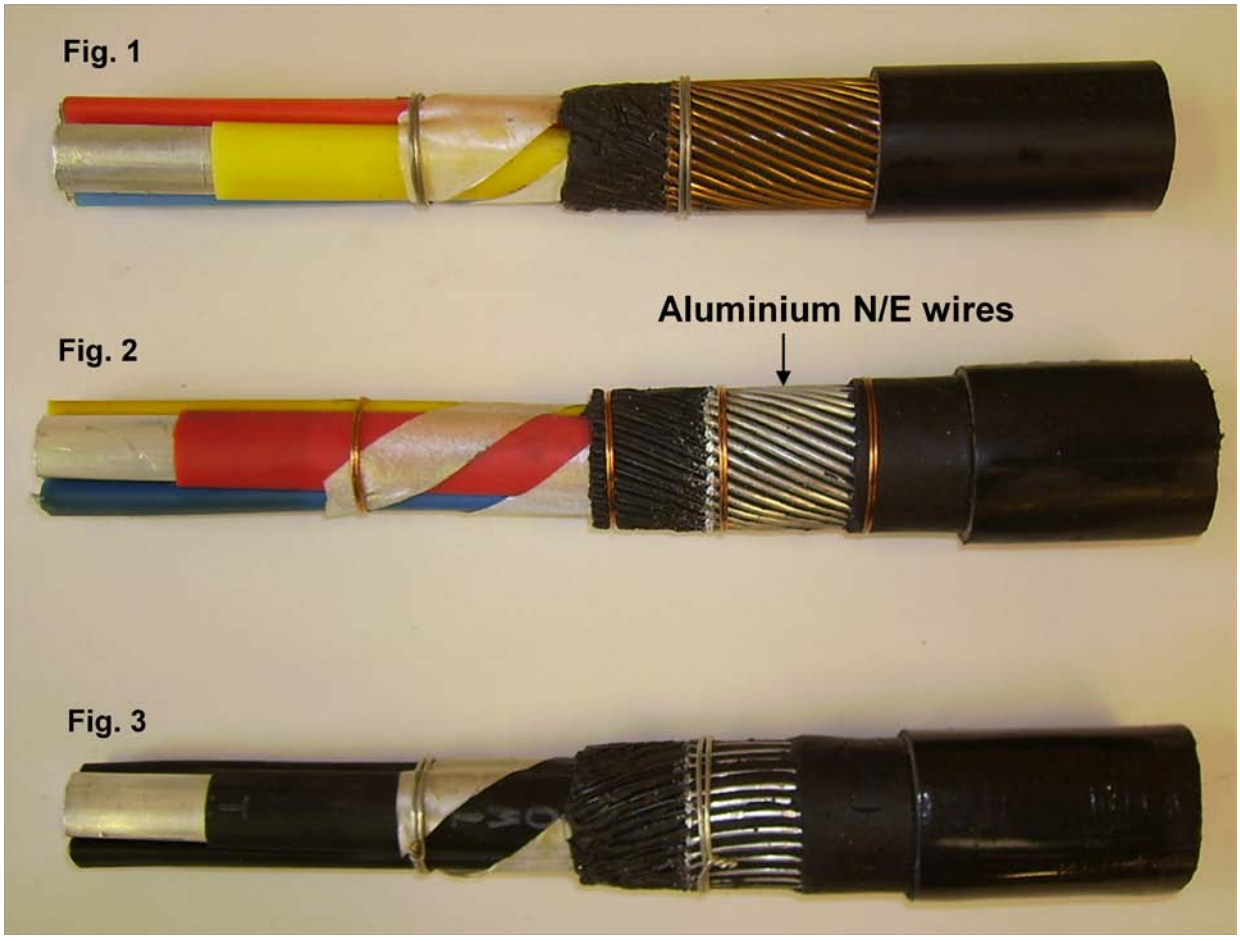


Fig. 2 shows waveform cable with aluminium neutral / earth (N/E) wires used before the copper version in fig.1
Fig. 3 shows one of the first designs of waveform cable introduced with black numbered cores, and aluminium N/E wires.



ScottishPower Low Voltage Cables

Paper Insulated Lead Covered Steel Tape Armoured (PILCSTA)

This type of LV cable was installed on the network up to the mid 1970's, prior to the introduction of waveform cable.

Cable Construction

A. Copper or aluminium conductors – 4 x stranded sector shaped
   - Large range of conductor sizes on the network 70-300mm^2 with an overall diameter range between 38.4 – 66.9mm
B. Layers of paper insulation impregnated with mineral oil compound – thickness 1.2 to 1.6mm between the conductor and sheath
C. Additional (belt) insulation layer
D. Lead sheath, covered with bitumen coated paper and hessian layers, as a bedding for the armour wires
E. Steel tape armours
F. Bitumen coated hessian tape serving (oversheath)

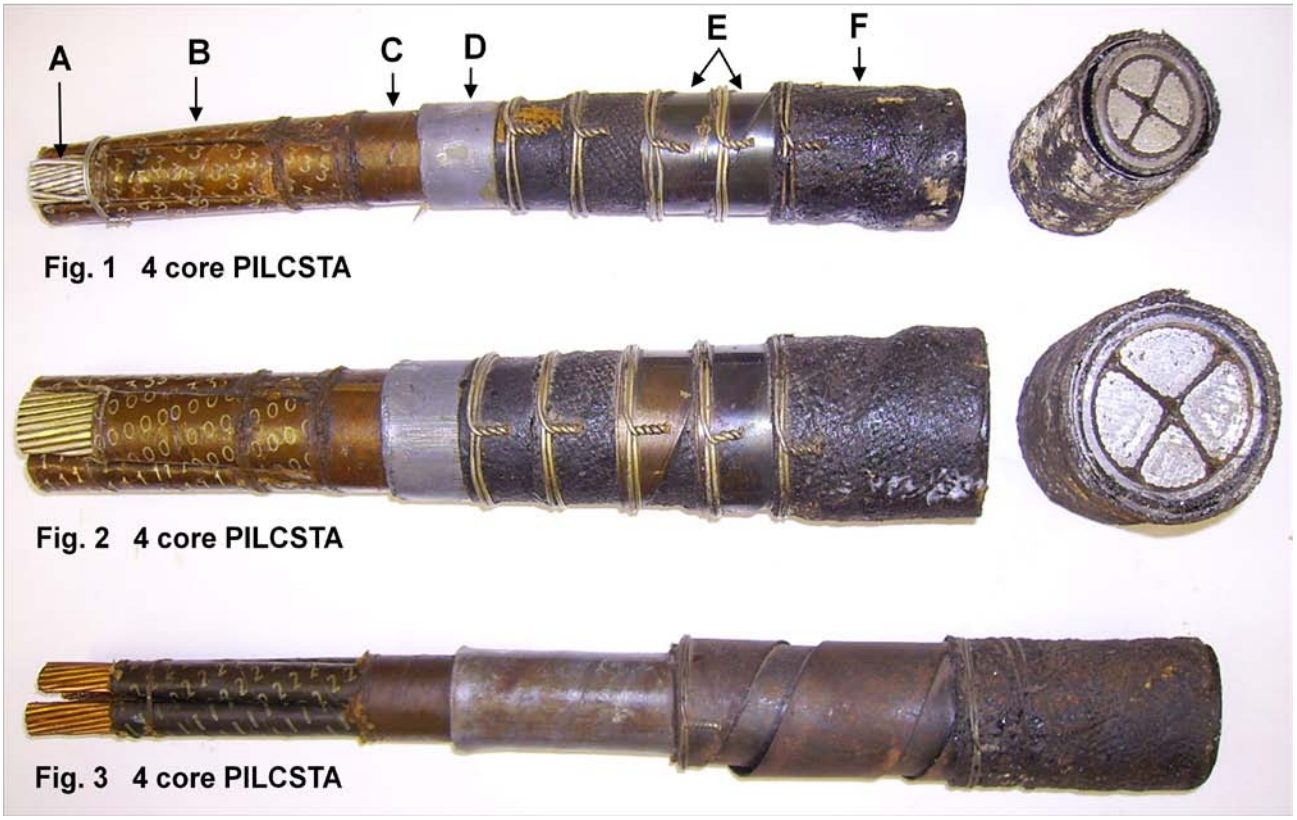


Fig. 1 4 core PILCSTA

Fig. 2 4 core PILCSTA

Fig. 3 4 core PILCSTA

ScottishPower Low Voltage Cables

Plastic Service Cables

The service cables below are used on the network to supply street lighting columns - fig.3, houses - figs. 1 & 4, small blocks of flats, small factory / commercial units - figs. 2,5,6.
Figs. 1 & 2 show combined neutral earth (CNE) cables used on new build installations, to latest wiring regulations.
Figs.3,4,5,6 show separate neutral earth (SNE) cables used on older installations.

Cable Construction

A. Aluminium conductor – sizes available 25 & 35 mm^2
   - Fig 6. Shows a copper cable available, but not commonly used
B. XLPE insulation
C. Copper wire neutral / earth
D. PVC oversheath
E. Covered neutral conductor
F. Copper earth wire

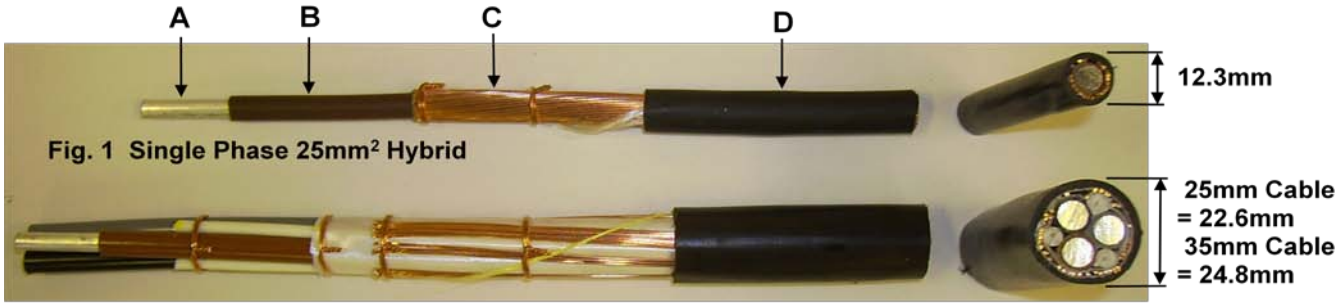


Fig. 1 Single Phase 25mm² Hybrid

Fig. 2 Three Phase Concentric

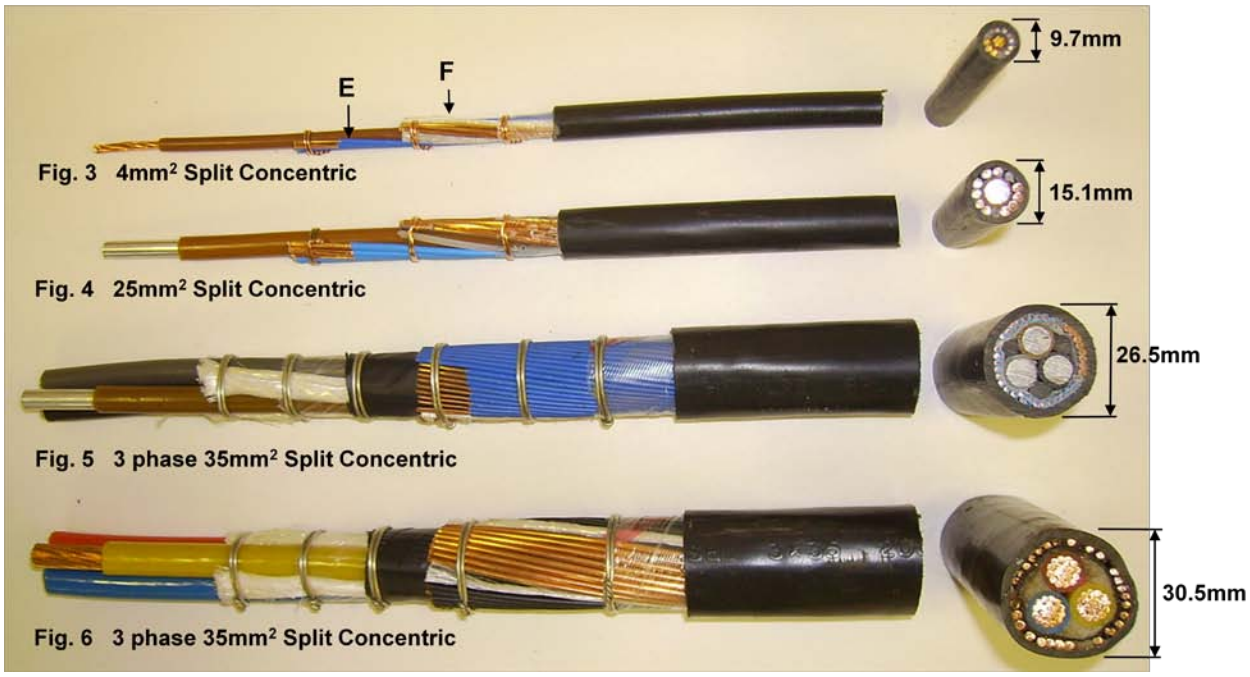


Fig. 3 4mm² Split Concentric

Fig. 4 25mm² Split Concentric

Fig. 5 3 phase 35mm² Split Concentric

Fig. 6 3 phase 35mm² Split Concentric

ScottishPower Low Voltage Cables

Paper Insulated Lead Covered Service Cables

The service cables below where used on the network prior to the introduction of plastic cables.

Cable Construction

A. Copper conductors – 2 or 4 core versions
   - Range of conductor sizes on the network 4 - 35mm^2
   - 2 core overall diameter range between 19 – 24.6mm
   - 4 core overall diameter range between 22 – 31.9mm

B. Layers of paper insulation impregnated with mineral oil compound – thickness 1.0 to 1.2mm between the conductor and sheath
C. Additional (belt) insulation layer
D. Lead sheath, covered with bitumen coated paper and hessian layers, as a bedding for the armour wires
E. Steel tape armours
F. Bitumen coated hessian tape serving (oversheath)

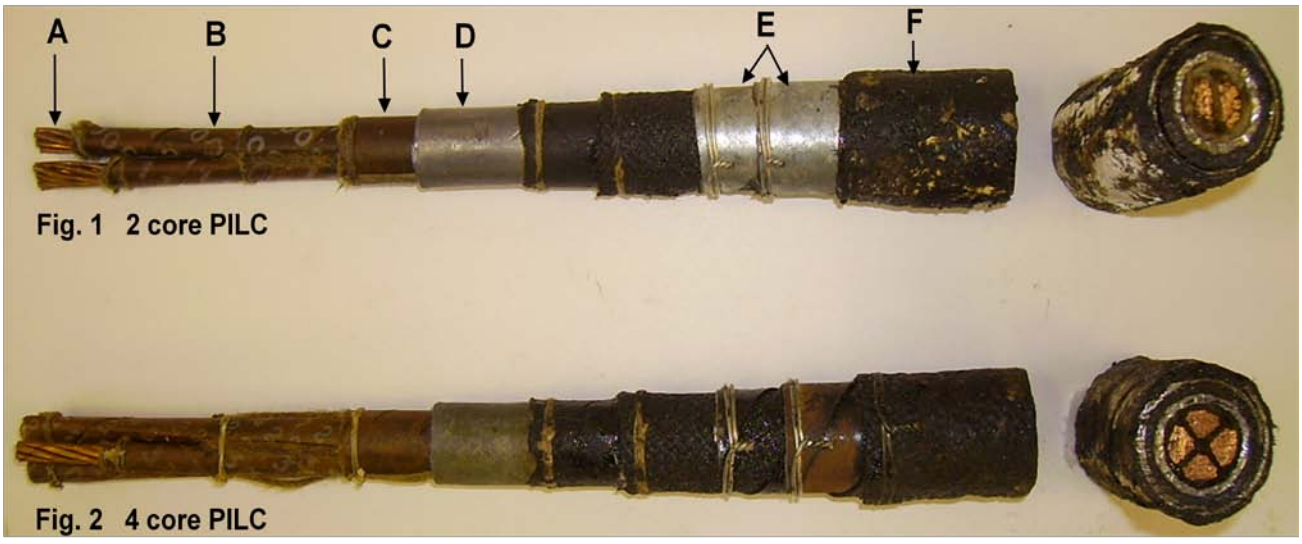


Fig. 1 2 core PILC

Fig. 2 4 core PILC

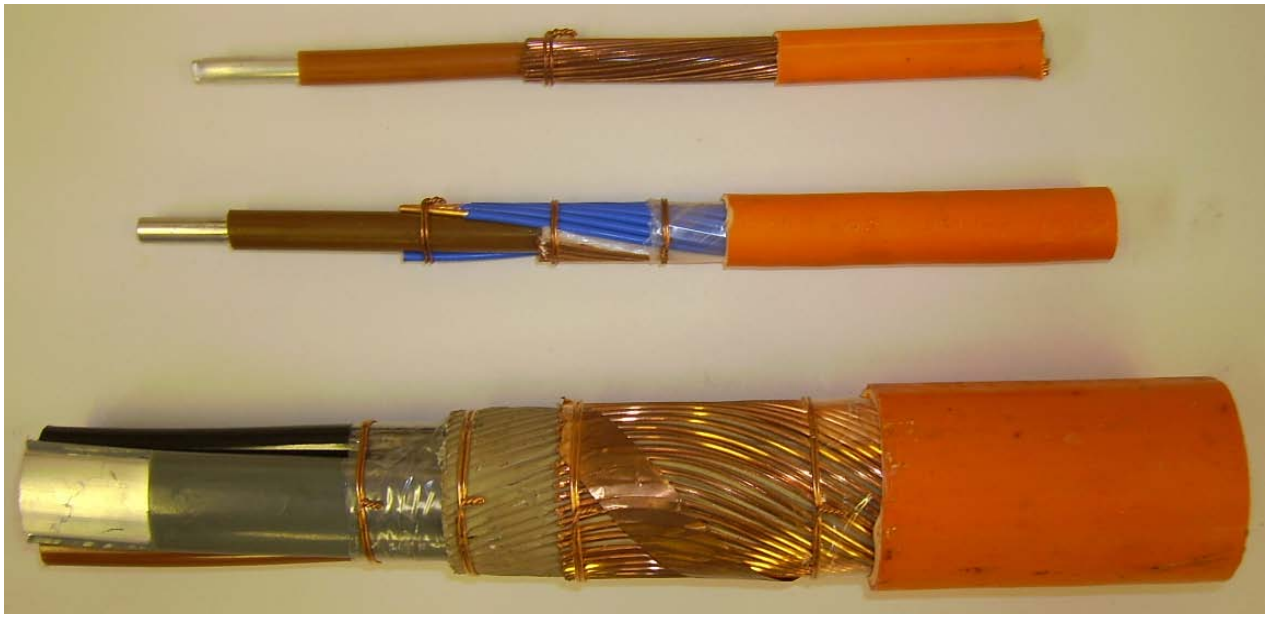
ScottishPower Cables

Low Smoke Zero Halogen Cables (LSOH)

For all the plastic low voltage service, mains and 11kV cables shown on the previous pages ScottishPower also buy versions with a LSOH oversheath, coloured orange.

These are used where significant cable runs inside buildings are required, and have the advantage of not giving off toxic fumes in the event of a fire.

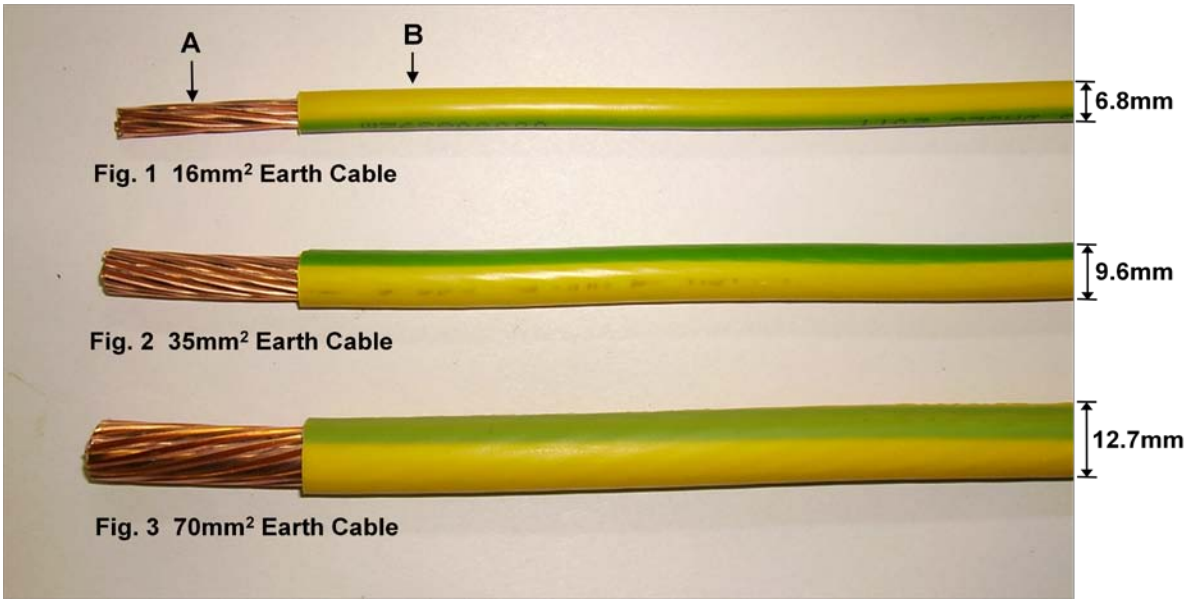
Examples of LSOH service and mains cables below, identical to standard cable construction apart from the oversheath material:



ScottishPower Earth Cables & Tape

Earth Cable

The earth cables below can be found in sub-stations, up poles and fig.1 in customers houses.



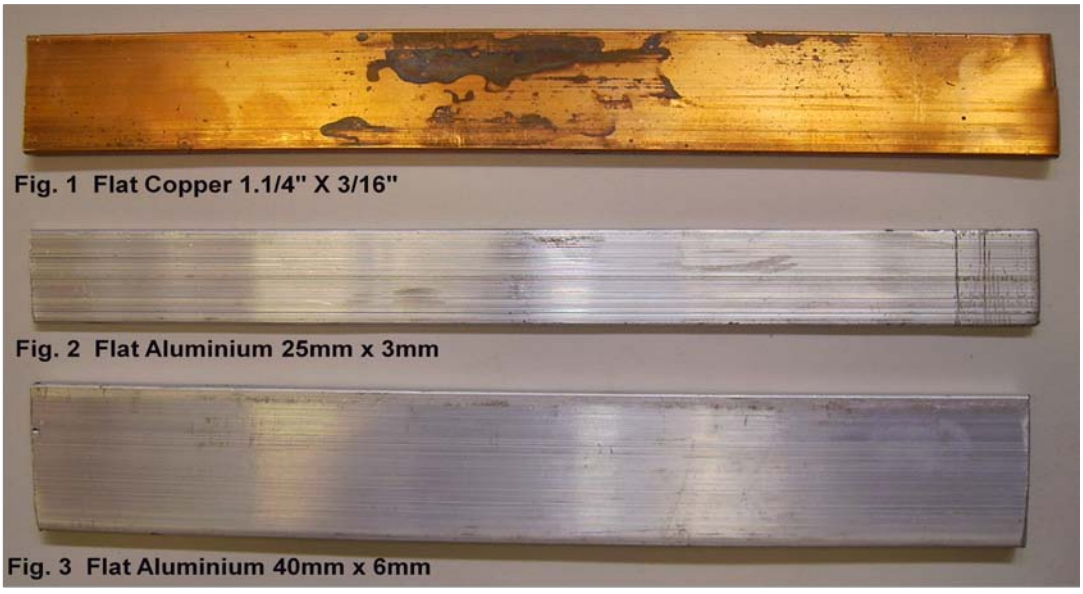
Cable Construction

A. Copper conductor – stranded round
   - Also available (but not shown) are 10mm^2 & 6mm^2 cables

B. PVC Oversheath – green / yellow

Earth Tape

The copper & aluminium earth tapes are used to connect all the metalwork / switchgear within substation buildings and outdoor compounds.



ScottishPower Earth Cables & Tape

In addition to the sizes on previous page 1.1/2" X 3/16" copper tape was used, with 25mm x 3mm & 40mm x 4mm copper now available as standard from stores.

Examples of earth cable & tape installations within a substation

Fig.1

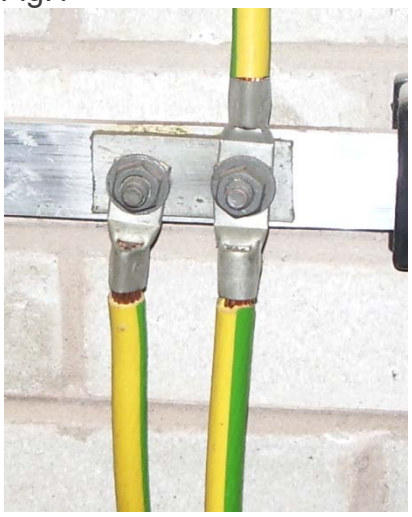


Fig.2

Fig.3

Fig.1 3 x Copper earth cables connected to main aluminium substation earth tape.
Fig.2 Copper earth tape connected to main aluminium earth tape.
Fig.3 Aluminium to aluminium tape connection.

N.B. Copper earth tape and cable has been a major target for theft in a number of areas. To help combat this there have been a number of increased security measures introduced into the company:

- Use of `identifiable` aluminium earth tape in place of copper where possible
- At selected sites the use of a high security steel pin fixing system for copper earth tape
- Superior high security steel padlocks and `lock-keeper` devices for installation at vulnerable sites.

Examples of Substation Equipment

Fig.1 shows a transformer removed from a substation building in an attempt to dismantle it, for the copper inside.

- There are not only huge risks electrically from this type of activity but because this equipment is oil filled a spill could also have a big environmental impact.

Fig.2 shows the copper winding from inside a transformer.

Figs.3 & 4 show an un-insulated LV board with exposed copper bus-bars and 4 x LV mains cables attached.

Fig.1

Fig.2

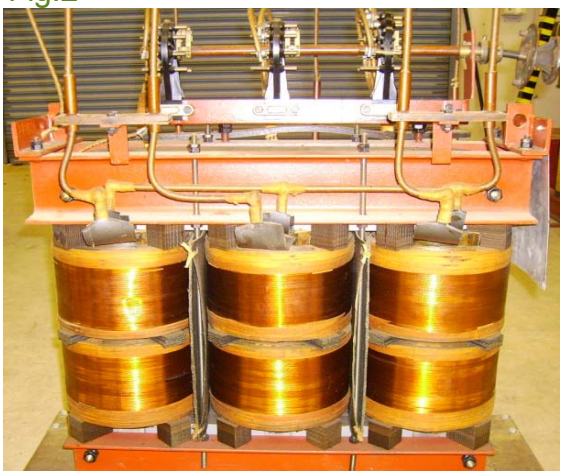


Fig.3

Fig.4

ScottishPower Contact Details

WHAT TO DO IF YOU FIND CABLES OR FOR QUERIES ABOUT EMPLOYEES OR CONTRACTORS (24/7)

If you find cables or earth tape which you believe may belong to ScottishPower (SP) or wish to ask about employees or contractors please contact the ScottishPower Grid Control room at Kirkintilloch. The Grid Control Room will not always know whether someone is employed as a contractor but it is the best place to start.

Tel: 0141 776 4185
Email: SWITCH1@ScottishPower.com.

TO CONTACT SP ALARM RECEIVING CENTRE (ARC) (24/7)

If, for any reason, you cannot get hold of Grid Control the Cathcart ARC is also manned 24/7. From Autumn 2012 ARC security staff will have access to records of all staff and contractors with photo passes.

Tel: 0141 568 2024/2025

OTHER USEFUL CONTACTS (NOT 24/7)

Charlie Hendrie (Security Manager Scotland and Ireland)
Tel: 0141 568 4725
Email: Charles.Hendrie@scottishpower.com

Harry Lees (Energy Networks)
Tel: 0141 614 1473
Email: Harry.Lees@scottishpower.com

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Many genuine SP employees still use PPE with old SP logos on. Equally the ownership of PPE with current or former SP logos on does not prove the person works for SP. By the end of 2012 all current SP staff should have a green photo pass with their name on it to prove their identity. Long-term contractors will also have an orange photo pass but contractors working off-site or in new sites where there is no access control system fitted will not necessarily have such passes.