FOREWORD

A cable, which has been Isolated from the System, can become Live with dangerous High Voltages by induction from adjacent cables, overhead lines or by natural phenomena. These induced voltages are most severe when high fault currents flow in the inducing circuits.

Differences in earth potential can also occur during fault conditions and these can appear at the point of work between any conducting components such as conductors, sheaths, metallic pipes, etc. and also between these components and the local earth.

High Voltage gradients can also appear across any break in a conductive path when that path is Isolated and Earthed at its remote ends.

Danger from such voltages can be eliminated by the use of Approved earthing procedures or by the provision of an insulated work environment.

1 SCOPE

This Safety Instruction applies the principles established by the ScottishPower Safety Rules (Electrical and Mechanical) and Company Safety Instructions to achieve Safety from the System for Persons working or testing on HV cable Systems and ancillary equipment and cables subject to induced voltage.

Power and auxiliary cables, even when Isolated from the System and Earthed, can be subject to dangerous voltages arising either from parallelism with adjacent Live HV circuits or from the passage of high fault currents. Appendices 1 and 2 contain guidance on the identification and spiking of cables. The Schemes contained in the Attachment to this Safety Instruction give guidance on the precautions to be taken when working on cables and ancillary equipment subject to induced voltage.

2 ISSUE RECORD

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3 ISSUE AUTHORITY

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Name: Phil Currie</td>
<td>Name: Phil Currie</td>
<td>Name: Colin Taylor</td>
</tr>
<tr>
<td>Title: Operational Compliance Manager</td>
<td>Title: Operational Compliance Manager</td>
<td>Title: Director, Engineering Services</td>
</tr>
</tbody>
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4 REVIEW

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5 DISTRIBUTION

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6 CONTENTS

FOREWORD .......................................................... 1
1 SCOPE ...................................................................... 1
2 ISSUE RECORD............................................................ 1
3 ISSUE AUTHORITY ...................................................... 2
4 REVIEW ................................................................... 2
5 DISTRIBUTION .......................................................... 2
6 CONTENTS .................................................................. 3
7 DEFINITIONS ............................................................. 4
8 APPARATUS IDENTIFICATION ....................................... 4
9 DANGERS .................................................................. 4
10 APPLICATION OF SAFETY INSTRUCTIONS ..................... 5
11 PHILOSOPHY OF CABLE AND SHEATH EARTHING REMOTE FROM THE POINT OF WORK ... 6
12 EXCAVATION TO EXPOSE HIGH VOLTAGE CABLES ............ 6
13 GENERAL REQUIREMENTS FOR WORK ON HIGH VOLTAGE CABLES ....... 7
14 GENERAL REQUIREMENTS FOR TESTING HIGH VOLTAGE CABLES .......... 8
15 GENERAL REQUIREMENTS FOR WORK OR TESTING ON AUXILIARY CABLES .......... 9

APPENDIX 1 – IDENTIFICATION AND SPIKING OF HIGH VOLTAGE CABLES .................. 10
APPENDIX 2 – IDENTIFICATION OF HV CABLES .............................................. 14

ATTACHMENT – INDUCED VOLTAGE WORK .............................................. 21

SCHEME 1 – OVERSHEATH AND JOINT BARRIER TESTS ON POWER CABLES ............ 29
SCHEME 2 – OVERSHEATH REPAIRS TO POWER AND AUXILIARY CABLES AND METALLIC COOLING PIPES .................................................. 31

SCHEME 3 – METALLIC SHEATH REPAIRS TO POWER AND AUXILIARY CABLES AND REPAIRS TO METALLIC COOLING PIPES .............................................................................. 32
SCHEME 4 – CUTTING AND CAPPING POWER CABLES ........................................... 33
SCHEME 5 – MAKING OR BREAKING DOWN STRAIGHT OR TRIFURCATING JOINTS OR 3-CORE STOP JOINTS INCORPORATING LEAD-THROUGH BUSHINGS ON POWER CABLES36

SCHEME 6 – REPAIRING POWER CABLES USING EXTENDED FERRULE REPAIR STRAIGHT JOINTS ........................................................................... 39
SCHEME 7 – MAKING OR BREAKING DOWN SINGLE CORE STOP JOINTS INCORPORATING TWO PLUG-IN CONDUCTOR FITTINGS ............................................. 41
SCHEME 8 – MAKING OR BREAKING DOWN SINGLE CORE STOP JOINTS INCORPORATING A LOCKED AND PLUG-IN CONDUCTOR FITTING .................................................................. 43
SCHEME 9 – MAKING OR BREAKING DOWN SINGLE CORE STOP JOINTS INCORPORATING A SOLIDLY-FERRULED CONDUCTOR AND A 'SLIDE-OVER' CENTRE SECTION ................................................. 45

SCHEME 10 – FITTING JOINT OUTER PROTECTIVE BOXES ON POWER CABLES ......... 47
SCHEME 11 – MAKING OR BREAKING DOWN SEALING ENDS ON POWER CABLES ....... 49
SCHEME 12 – REPAIRING OIL AND GAS LEAKS ................................................... 51
SCHEME 13 – WORK IN CABLE SHEATH LINK BOXES NOT INVOLVING THE CUTTING OR DISCONNECTION OF BONDING LEADS ................................................ 52
SCHEME 14 – REPLACING CABLE SHEATH LINK BOXES BY CUTTING AND JOINTING EXISTING BONDING LEADS .............................................................. 53
SCHEME 15 – REPLACING CABLE SHEATH LINK BOXES BY BREAKING DOWN EXISTING LINK BOXES .......................................................................... 56
SCHEME 16 – CUTTING AND CAPPING AUXILIARY CABLES ..................................... 59
SCHEME 17 – JOINTING AUXILIARY CABLES ......................................................... 62
SCHEME 18 – GLANDING-OFF AUXILIARY CABLES AT TERMINAL BOXES ............... 64
SCHEME 19 – TERMINATIONS IN FULLY INSULATED BOXES .................................... 66
SCHEME 20 – TERMINATIONS IN NON-INSULATED METALLIC BOXES ...................... 67
SCHEME 21 – GENERAL COMMISSIONING TESTS ON AUXILIARY CABLES ................ 68
SCHEME 22 – OVERSHEATH TESTING ON INSULATED SHEATHS OF AUXILIARY CABLES .... 69
SCHEME 23 – DIELECTRIC TESTS ON AUXILIARY CABLES ..................................... 70
7 DEFINITIONS

For the purpose of this Safety Instruction and Attachment the following definitions apply:

(i) **Induced Voltage Working** – the method of working which employs the procedures set down in this Safety Instruction to protect Persons against dangerous induced voltages or differences in earth potential;

(ii) **Earthed Working** – the method of working where all Apparatus and conductive materials which are exposed in the work area are effectively bonded together and connected to earth at the point of work;

(iii) **Insulated Working** – the method of working where the Person, using Approved equipment, is insulated from contact with objects at different potentials;

(iv) **Adequate Earth** – a common point of connection for establishing an equipotential throughout the area of work;

(v) **Bridging Earth** – a form of Drain Earth applied at Cable Sheath Link Boxes, joint bays or other points of work to provide an efficient connection to earth or to eliminate differences in potential. Bridging Earths include Triflex and Uniflex Earths;

(vi) **Cable Sheath Link Box** – a box, kiosk or pillar containing cable sheath disconnecting links and/or Sheath Voltage Limiters (SVLs).

Terms printed in bold type are as defined in the ScottishPower Safety Rules (Electrical and Mechanical).

8 APPARATUS IDENTIFICATION

8.1 **Apparatus** associated with the cables on which work or testing is to be carried out shall be readily identifiable or have fixed to it a means of identification, which will remain effective throughout the course of work.

8.2 Cables shall be identified at their termination by means of the permanent identification label on the Apparatus to which they are connected or by their appropriate Circuit Identification.

8.3 At other points on cable runs where work or testing is to be carried out, after positive identification by means of reference to cable records and Approved testing methods, the cables on which work or testing is to be done shall be marked by paint or tape or similar means which will clearly identify the cable throughout the course of the work or testing. On the completion of the work or testing such identification shall, where reasonably practicable, be removed or obliterated.

9 DANGERS

9.1 The main Dangers to personnel working on HV cables are electric shock, burns, asphyxiation or falls arising from:

(i) Mistaking HV cables on which it is unsafe to work for those on which it is safe to work under the conditions laid down;

(ii) Voltage difference when the sheath or cores at the point of work are connected to a different earthing area from the one at the point of the work, and an earth fault occurs in one of these earthing areas;

(iii) Induced voltages which may result from HV circuits running physically parallel to the cable being worked on carrying fault current, or from the cable being worked on being connected to an overhead line circuit;

(iv) Proximity of exposed Live Apparatus, other cables or services;

(v) The sudden release of gas from pressurised cables.
9.2 **Danger** from induced voltages and rise of earth potential can be avoided by employing the following methods:

(i) *Earthed Working*, where the voltages are controlled by using a variety of earthing methods; or

(ii) *Insulated Working* including, where appropriate, *Bridging Earths* to eliminate difference in potential.

10 **APPLICATION OF SAFETY INSTRUCTIONS**

10.1 This Safety Instruction shall be applied to all HV power and auxiliary cable installations. However, those sections concerned with *Induced Voltage Working* need not be applied in the following circumstances:

(i) On cables operating at rated phase voltages up to and including 33kV connected to the HV Distribution System unless either:
   - the circuit to be worked on is specified on a list contained in an *Approved* document; or
   - the circuit meets the criteria specified in the same *Approved* document requiring the application of *Induced Voltage Working* precautions.

On these cables, **Danger** from differences in potential between cable sheaths and cable conductors connected to different points in the earth System shall be managed by bonding together the cable sheaths using a temporary continuity strap until a permanent connection is made. This includes situations where a cable termination is being carried out in which case the cable sheath shall be bonded to the local earth System. *Approved* insulated rubber gloves shall be worn whilst applying a temporary continuity strap;

(ii) On cables operating at rated phase voltages above 33kV where it has been established by calculation, test or existing knowledge that there is no likelihood of dangerous voltages arising or when all adjacent circuits are limited to Systems having resistance earthing in which the fault level does not exceed 2.5kA.

Two conditions pertaining to electromagnetic induction and rise in earth potential can arise and the appropriate recommended voltage limits are:

   - 60 volts for steady state, i.e. continuous induced voltages;
   - 650 volts for fault conditions where the fault current can be cleared within 0.2s or 430 volts where clearance times are more than 0.2s.

(iii) When working on telecommunications cables where other codes of practice apply.

10.2 It should be noted that it is possible for induced voltages to appear on the terminal connections and sheath of, for example, an HV motor cable which runs physically parallel and close to other HV single core cables when a fault occurs on one of them. The magnitude of the induced voltages will be mainly dependent on:

(i) The value of fault current;

(ii) The length of the physical parallel run;

(iii) The path of the return fault current.

For guidance on these specific criteria, refer to the *Approved* document referred to in 10.1 (i) above.

10.3 Where *Induced Voltage Working* is necessary:
(i) For power cables, *Earthed Working* shall, where reasonably practicable, be applied but where this is not reasonably practicable, or is undesirable, *Insulated Working* may be adopted as an alternative;

(ii) For auxiliary cables, as it is impracticable to develop effective means for earthing the conductors which can be guaranteed to sustain the passage of the resulting high value of induced current, *Insulated Working* should generally be applied. However, at non-insulated, metallic terminal boxes a combination of *Insulated Working* and *Earthed Working* may have to be employed;

(iii) The detailed requirements for *Induced Voltage Working* are contained in the Attachment to this Safety Instruction.

11 PHILOSOPHY OF CABLE AND SHEATH EARTHING REMOTE FROM THE POINT OF WORK

11.1 Where *Induced Voltage Working* is not necessary, the cable cores at each end shall normally be *Earthed*. There would be no specific requirements for earthing the cable sheaths or rearrangement of cable sheath bonding links remote from the point of work.

11.2 Where *Induced Voltage Working* is necessary, the normal method should be for *Primary Earths* to be applied and maintained on the cable cores at each end and within the *Isolated* zone. However, it is recognised that safe working conditions can still be achieved by adhering to the Schemes set out in this Safety Instruction but with the cable cores being ‘earth free’ at each end by the cables being physically disconnected from the *Primary Earths* applied at the *Points of Isolation*. Regardless of the method used, there is no specific requirement for cable sheath earthing or rearrangement of cable bonding links remote from the point of work, except when changing *Cable Sheath Link Boxes*.

12 EXCAVATION TO EXPOSE HIGH VOLTAGE CABLES

12.1 Reference shall be made to records of the cables and recognition shall be given to the possible presence of other services or cables owned by third parties. Use shall be made of *Approved* specialised detection instruments to determine, where necessary, the position of the required cable(s) and other cables and services in order to excavate safely at the appropriate position. Allowance shall be made for the possibility of errors or inaccuracies in the records, or changes in local topography which have not been recorded and for the possibility of unauthorised movement of the cables.

12.2 Excavations for this purpose within the boundaries of a power station or a transmission substation shall be done under the terms of a *Limited Work Certificate*. In distribution substations consideration shall be given to the issue of a *Limited Work Certificate* for excavations. In locations where ScottishPower is not the occupier, consideration shall be given to a possible requirement by the occupier for other safety documents to be obtained and other safety procedures followed in addition to ScottishPower’s Rules and procedures.

12.3 If cable tiles or other cable markers or protectors are exposed during excavation, it shall not be assumed that they are in their correct position directly above the cables they were originally intended to protect. Previous excavations and careless backfilling may have misplaced such cable markers or protectors. The position of a cable is not certain until it is uncovered and identified.

12.4 The excavation shall, where reasonably practicable, be made large enough to expose all the cables, pipes and ducts necessary to establish the position of the required cable(s).

12.5 HSE Publication HSG47 *Avoiding Danger from Underground Services* gives advice on the procedures and practices that shall be followed to reduce the risk of accidents.
13 GENERAL REQUIREMENTS FOR WORK ON HIGH VOLTAGE CABLES

13.1 Work shall not commence on any HV cable unless the Person in charge of the work is in receipt of a Safety Document and is personally instructed at the point of work by the Senior Authorised Person issuing the Safety Document.

13.2 Unless the work is restricted to that which can be done under a Limited Work Certificate the circuit shall be Isolated and Earthed and dependent on the requirements of 13.4, a Permit for Work issued.

13.3 No work, other than work external to the pressurised parts, shall be carried out on gas pressure cables or associated gas pressure equipment until gas pressure has been adjusted to a level which avoids Danger.

13.4 When any HV cable is to be cut or any HV cable joint or chamber opened, the Senior Authorised Person issuing the Safety Document shall identify the cable, joint, cable box or chamber as that covered by the Safety Document and on which it is safe to work. Identification and proving Safety from the System shall be carried out using an Approved method and Approved equipment in accordance with Appendices 1 and 2 of this Safety Instruction.

13.5 As final verification and, subject to the requirements of (i) or (ii) below or 13.8, the cable shall be spiked using an Approved spiking device at any point at which the cable is to be cut. The spiking device shall be applied to the cable by or under the Personal Supervision of the Senior Authorised Person issuing the Safety Document. The spiking operation itself shall be carried out by the Senior Authorised Person or under his Immediate Supervision.

The cable may be cut without the requirement for the cable to be spiked, if it is established that there can be no error in the identification of the cable by it being physically traced over its whole length from the point of work to:

(i) a termination where either a Primary Earth or Drain Earth is applied or the terminal Apparatus has been proved not Live; or
(ii) a point on the cable which has previously been identified and the conductor worked on, after which the cable has not been made Live.

The initial cut into the cable shall be carried out by, or under the Personal Supervision of, the Senior Authorised Person issuing the Safety Document (this also applies to the first cut into each core of a group of single core cables). Subsequent cuts into the cable may be carried out by, or under the Personal Supervision of the Safety Document recipient, providing that the cable can be physically traced from the proposed cut to a point as per (i) or (ii) above.

13.6 Identification through visual tracing is not acceptable if the cable is hidden from view for any distance, no matter how short.

13.7 The positively identified cable shall be suitably marked by paint or tape or similar means at the point of work by the Senior Authorised Person issuing the Permit for Work.

13.8 Where it is required to carry out repairs to:

(i) the outer sheath and general physical protection of the cable including oil and gas ways of an oil or gas pressure cable; or
(ii) 132kV and higher voltage cables, using an extended ferrule repair straight joint
and it is not desirable to cause the additional damage created by spiking, the above work may be done without spiking the cable provided it has been identified at the point of work by the use of an Approved method and Approved equipment in accordance with Appendices 1 and 2 of this Safety Instruction and suitably marked. The identification tests shall be carried out by the Senior Authorised Person issuing the Permit for Work in the presence of the Authorised Person receiving the Permit for Work.

Where it is believed superficial damage has occurred to a cable outer sheath, the cable shall be Isolated, Earthed and identified at the point of damage using Approved methods. The damaged area shall be assessed with care and without undue disturbance of the cable. If there remains:

- any doubt over the nature of the superficial damage, possibly caused by obstructions such as ducting, dirt, tape etc.; or
- concern over the condition of the cable being returned to service due to, for example, the inspection revealing irregularity in the cross sectional shape of a polymeric cable or that copper screening wires have been displaced beneath the sheath and/or the inner insulation 'bruised'

then the spiking procedure shall be followed before further investigation and repair takes place. The removal of the lead or corrugated aluminium sheaths on a solid insulated HV cable is prohibited without first spiking the cable.

13.9 When work is to be done on an HV cable or cable terminations and the cable is directly connected to an overhead line, Danger from induced or impressed voltages on the overhead line shall be excluded from the cable by applying either Primary Earths or Drain Earths between the cable and the overhead line.

13.10 The extent of damage to any cable shall not be taken as proof that a cable is not Live. Final verification by spiking is required at a safe distance from the damage.

13.11 Where a cable has been found damaged, consideration shall be given to the Danger posed by the possibility that other cables or services have been damaged at the same Location.

13.12 Live cables in proximity – If there are other cables in proximity to those which are to be worked on, the Senior Authorised Person and recipient of the Safety Document shall ensure the Working Party are warned of any additional Danger. The Senior Authorised Person shall record any suitable control measures on the Safety Document and where necessary use Danger Notices to form a demarcation barrier.

13.13 On cables operating at rated phase voltages up to and including 33kV, Danger from differences in potential between cable sheaths and cable conductors connected to different points in the earth System shall be managed by bonding together the cable sheaths using a temporary continuity strap until a permanent connection is made. This includes situations where a cable termination is being carried out in which case the cable sheath shall be bonded to the local earth System. Approved insulated rubber gloves shall be worn whilst applying a temporary continuity strap.

14  GENERAL REQUIREMENTS FOR TESTING HIGH VOLTAGE CABLES

14.1 Where applicable, testing on any HV cable shall be in accordance with PSSI 9. Testing shall not commence unless the Person in charge of the testing is in receipt of a Safety Document.

14.2 Where conductor dielectric testing is necessary, the joint barriers and any SVLs fitted in Cable Sheath Link Boxes along the route shall be short circuited and Earthed for the period of the tests (see Fig. 1 below).
14.3 When testing oversheaths and joint barriers on insulated sheath Systems and Induced Voltage Working is not required, any SVLs fitted in Cable Sheath Link Boxes along the route shall be disconnected for the period of the tests. The SVLs may then also be tested.

14.4 Before cancelling the final Safety Document, the Senior Authorised Person shall satisfy himself that all links and earthing arrangements are returned to the correct operational mode.

15 GENERAL REQUIREMENTS FOR WORK OR TESTING ON AUXILIARY CABLES

15.1 The relevant precautions set down in Sections 8 and 12 shall be observed.

15.2 Where it has been determined that Induced Voltage Working does not apply, work or testing shall be carried out in accordance with PSSI 12.

15.3 Before work commences on an auxiliary cable that contains protection or SCADA circuit(s) an Authorised Person with knowledge of these systems shall be consulted. Suitable precautions shall be taken to avoid Danger and risk to the System and where he deems it necessary a Limited Work Certificate shall be issued.
APPENDIX 1 – IDENTIFICATION AND SPIKING OF HIGH VOLTAGE CABLES

1 Scope

This Appendix sets out the procedure to be followed to comply with PSSI 5 in regard to the identifying and spiking of HV cables before work is carried out on them. This procedure shall be followed before work is carried out on:

(i) Cables connected to the System which have been Isolated and Earthed;
(ii) Out-of-Use cables. These are cables which have at one time been connected to the System, but having become redundant to their original purpose have been disconnected from the System and left in situ;
(iii) Cables connected to the System which have been Isolated and Earthed but are pot ended or open circuited at some point along the length of cable.

This Appendix also details the procedure to be followed when it is necessary to disconnect links in a freestanding cable disconnecting chamber.

2 Responsibility

The Senior Authorised Person supervising the work or testing to be carried out shall be responsible for:

(i) Before work or testing is commenced confirming that the cable to be identified is Isolated and Earthed and that all reasonable precautions to prevent unauthorised interference have been taken;
(ii) Ensuring that he is clearly identified to all personnel involved and that his instructions are given personally or over his own signature;
(iii) Ensuring that all reasonable safety precautions are taken;
(iv) Issuing the relevant Safety Documents;
(v) Personally identifying the cable or chamber to be worked on.

3 Identification and Spiking of Cables Connected to the System

Before work is commenced the following precautions shall be taken to identify the cable(s) to be worked on at the point of work.

3.1 Identification of Cables

(i) The appropriate cable records shall be consulted to indicate the position of the cable(s) in relation to all cables, pipes or ducts at the point of work;
(ii) The excavation shall, whenever reasonably practicable, be made large enough to expose all cables, pipes and ducts necessary to establish the position of the required cables;
(iii) Past and present practices in regard to cable types, covering, armouring, jointing and depth of laying may provide some degree of identification;
(iv) If there is only one cable or one set of single core cables in trefoil formation in the track and (i) to (iii) above do not provide any conflicting evidence, the cable(s) may now be taken as identified for spiking purposes. See Note below;
(v) If there is more than one cable or one set of single core cables in trefoil in the track, or any doubt remains, then the cable(s) to be worked on shall be identified using an Approved method and Approved equipment as detailed in PSSI 5 Appendix 2. See Note below.
Note: Cable records cannot always be relied upon as an accurate representation of what is in the ground. Positional changes can occur, customers’ cables may be omitted and more recently, Independent Network Operator (IDNO) circuits may not be shown. The records are only as good as the information fed back to the Data Management updating team. Signal injection shall, where reasonably practicable, be used to aid the identification process – where there is any doubt of identification based upon the use of records, signal injection shall be used.

3.2 Spiking of Cables

(i) The purpose of cable spiking is to prove that the cable spiked is not Live. While spiking provides evidence of the state of the cable, it shall not be taken as proof of the identity of the cable;

(ii) If not already issued, a Sanction for Test shall be issued by the Senior Authorised Person to himself. The wording of the Sanction for Test shall include all actions necessary to complete the required tests, e.g. carry out cable identification, establish insulation conditions before and after spiking, identify cable cores after cutting;

(iii) Before spiking, the insulation condition of the cable cores shall be established by the use of an insulation tester, e.g. a Megger or similar instrument;

(iv) The spiking device shall be of an Approved type and shall be used in accordance with the relevant instructions;

(v) The appropriate control room Control Person shall be informed and the spiking operation shall be carried out by the Senior Authorised Person or by another Person under the Immediate Supervision of the Senior Authorised Person. The control room Control Person shall then be contacted by the Senior Authorised Person to check for SCADA alarms. The Control Person shall positively confirm no related SCADA alarms or change of state indications have been received on the monitoring system. Attention shall be given to the Location of the cable and the possibility that the cable may be controlled as part of a customer’s network or an IDNO network, in which case it may be necessary for the ScottishPower control room Control Person to liaise with the person in control of that other network. If there are any associated SCADA alarms or change of state indications, the cable shall be treated as having been a Live HV cable and it shall be dealt with accordingly;

(vi) After spiking, the insulation conditions of the cable cores shall be re-checked to ensure that the cable to be worked on has been shorted to earth by the spike. If no change of insulation conditions is evident, consideration shall be given to the possibility that either:

(a) The wrong cable has been spiked in which case the procedure shall be suspended and consideration given to the possibilities that the cable that has been spiked is the wrong HV cable, a redundant cable or an LV cable; or

(b) The spike has not penetrated the cores of the cable, in which case a further spiking operation with a second spiking device shall be undertaken. Insulation conditions shall again be re-checked to ensure that the cable to be worked on has been shorted to earth by the spike. If there is still no change in insulation conditions and there is any doubt as to whether the cable is HV or LV, the spiking device and the cable shall be treated as Live LV. The Primary Earths shall be re-applied. If the spiked cable is assumed to be an LV cable, local network checks shall be carried out to ascertain if any supplies have been lost due to blown fuses. LV incident controller(s) shall also be consulted and advised of the situation. To facilitate removal of the spiking devices a Live strip and cut shall be carried out on both sides of and at a safe distance from the spiking devices in accordance with PSSI 12 Appendix 2.
(vii) The Primary Earths shall be re-applied before the spiking device is removed from the cable;

(viii) The cable may now be cut by the Senior Authorised Person, or by another Person under the Personal Supervision of the Senior Authorised Person. If appropriate the cores may be separated to permit core identification to be carried out;

(ix) When single core cables which are part of the same circuit are to be worked on, every core to be worked on shall be spiked;

(x) The Sanction for Test shall be cancelled and a Permit for Work shall be issued to allow work on the cable(s) to proceed.

4 Identification and Spiking of Out-of-Use Cables

Where a section of HV cable that is out-of-use and not connected to the System is to be worked on, it is not possible to issue a Sanction for Test. However, where it is reasonably practicable to access one or more cable ends or terminations, it may be possible to carry out identification by signal injection and/or insulation condition tests before and after spiking.

4.1 Identification of the Cables

(i) Identification of the cable shall be carried out as outlined in 3.1. Where there is any doubt as to whether the cable is HV or LV it shall first be spiked. Following spiking, the cable shall be treated as if it were a Live LV cable and opened using LV Live working techniques and tested to prove it not Live. If the spiked cable is assumed to be an LV cable, local network checks shall be carried out to ascertain if any supplies have been lost due to blown fuses. LV incident controller(s) shall also be consulted and advised of the situation. To facilitate removal of the spiking devices a Live strip and cut shall be carried out on both sides of and at a safe distance from the spiking devices in accordance with PSSI 12 Appendix 2;

(ii) If there is more than one cable or more than one set of single core cables in trefoil formation in the track, then in addition to steps outlined in 4.1 (i) and where reasonably practicable all other cables known to be connected to the System shall be identified using an Approved method and Approved equipment. PSSI 5 Appendix 2 details the Approved methods of identification for HV cables.

4.2 Spiking of Out-of-Use Cables

(i) Where it is reasonably practicable to establish the insulation condition of the cable, the procedure set out in 3.2 (iii) to (vi) shall be followed. If there is a significant change in insulation conditions then this can be taken as proof of the cable’s identity. If there is no significant change in insulation condition, the procedure in 4.2 (iii) shall be followed;

(ii) Where it is not reasonably practicable to establish the insulation condition of the cable the appropriate control room Control Person shall be informed and the cable to be worked on shall be spiked without delay. The control room Control Person shall be informed that the cable has been spiked and shall positively confirm no related SCADA alarms or change of state indications have been received on the monitoring system. After a suitable time delay the control room Control Person shall again be contacted to confirm no related customer no-supply calls have been received. Attention shall be given to the Location of the cable and the possibility that the cable may be controlled as part of a customer’s network or an IDNO network. In such case the ScottishPower control room Control Person shall liaise with the person in control of that other network during the spiking procedure. If there are any associated SCADA alarms, change of state indications or customer no-supply calls, the cable shall be treated as having been a Live HV cable and it shall be dealt with accordingly;
If there are no SCADA alarms, change of state indications or customer no-supply calls and there was no doubt about the cable being HV, the spiking device and spike may now be removed from the cable.

Where there remains any doubt about the cable being HV or LV the spiking device and the cable shall now be treated as Live at LV. Local network checks shall be carried out to ascertain if any supplies have been lost due to blown fuses. LV incident controller(s) shall also be consulted and advised of the situation. A Live strip and cut shall be carried out either side of and at a safe distance from the spiking device in accordance with PSSI 12 Appendix 2.

5 Identification and Spiking of Open Circuited or Pot-Ended Cables

Where an HV cable is open circuited or pot-ended but it is still connected to the System, the procedure to be adopted in identification and spiking shall be as detailed in 3 above with the exception of when there is more than one cable in the track or more than one set of single core cables in trefoil formation, identification by testing may not be possible. In this case, whenever reasonably practicable, all other cables known to be connected to the System shall be identified using an Approved method and Approved equipment as detailed in PSSI 5 Appendix 2.

6 Disconnection of Links in Freestanding 33kV Cable Disconnecting Chambers

Freestanding cable disconnecting chambers are readily identifiable by means of labels attached to the chambers. The following procedure shall be adopted to prove the cables in the chamber are not Live before a Permit for Work is issued to disconnect any links in the chamber.

(i) All cables connected to the chamber shall be Isolated and Earthed;
(ii) The Senior Authorised Person shall identify the chamber where the links are to be disconnected and shall issue a Limited Work Certificate to an Authorised Person to remove the cover of the chamber;
(iii) The Authorised Person shall remove the cover under the Personal Supervision of the Senior Authorised Person;
(iv) When the cover has been removed the Limited Work Certificate shall be cancelled and an Approved Voltage Indicator used, by the Senior Authorised Person, to verify that the cable terminations are not Live. The Voltage Indicator shall be tested immediately before and immediately after use;
(v) Having proved that the conductor terminations are not Live the Senior Authorised Person may then issue a Permit for Work to remove the cable disconnecting links.
APPENDIX 2 – IDENTIFICATION OF HV CABLES

1 Scope

Earlier sections of PSSI 5 refer to the use of an Approved method and Approved equipment for the identification of an HV cable which is one of several in a track. This Appendix sets out the Approved method and Approved equipment for such identification to meet the requirements of PSSI 5.

2 Identification

The Approved method of identification of a cable shall be by signal injection or by physically tracing over its whole length from the point of work to:

(i) a clearly identifiable termination where a Primary Earth or Drain Earth is applied or the terminal Apparatus has been proved not Live by an Approved means; or
(ii) a point on the cable which has previously been identified and the conductor worked on, after which work the cable has not been made Live.

Identification through visual tracing is not acceptable if the cable is hidden from view for any distance no matter how short.

2.1 The Approved method for identification by signal injection shall be by phase to phase or phase to earth injection of a signal into the cable which shall be detected at the point of work using:

(i) Approved phase to phase signal injection equipment; or
(ii) Approved phase to earth signal injection equipment.

The phase to earth signal injection method shall only be used where the use of the phase to phase method is not practicable.

2.2 The method of approach to injection testing for identification is dependent on the cable use or type, and for the purpose of this procedure shall fall into one of the following categories:

(i) HV cable other than transformer cable;
(ii) HV transformer cable;
(iii) Open circuited, pot-ended or out-of-use HV cable;
(iv) HV single core cables.

2.3 Before testing for identification by injection, preliminary identification of the cable shall be carried out in accordance with 3.1 (i) to (iii) of PSSI 5 Appendix 1.

3 Procedure

3.1 HV Cable other than a Transformer Cable

A Sanction for Test shall be issued for the cable section to be identified using Approved phase to phase or if that is not practicable, phase to earth injection equipment in accordance with the following procedure.

(i) Remove the Primary Earth from one end of the cable to be identified and connect the signal generator phase to phase or if that is not practicable, phase to earth via Approved test connections;
(ii) When carrying out identification using phase to phase signal injection equipment the test signal shall be applied to the cable under test with the cable having a short between phases, at one point only, beyond the point of work, see Fig. A1(a). When using phase to earth signal injection equipment the test signal shall be applied to the cable under test, with a short between phase and earth, at one point only, beyond the point of work, see Fig. A1(b). A Primary Earth may be used to provide the short between phases or from phase to earth as the case may be;

![Diagram of signal injection equipment](image)

(iii) At the point of work the detecting surface of the signal receiver shall be applied to every cable. The signal receiver shall be moved along the length of each cable, listening for the definitive signal. In addition the lay of the cores will produce a rise and fall in the received volume of the signal in the cable being identified, this is distinguishable from an induced signal in a cable which will have a constant volume when the receiver is moved along the cable;

(iv) Having identified the cable carrying the injected signal, the receiver shall be used to check the area on either side and below the cable to ensure that the signal is not being emitted by an adjacent cable at the side or underneath the identified cable;

(v) The identified cable shall then be marked by paint or tape or similar means which will clearly identify the cable throughout the course of work or testing;

(vi) Where any doubt remains, all other cables in the track shall be identified by use of the appropriate procedure within this Appendix. A separate Sanction for Test shall be issued for each circuit involved.
3.2 HV Transformer Cable

3.2.1 HV/LV distribution transformer HV cable

A Sanction for Test shall be issued for the cable section to be identified using Approved phase to phase injection equipment in accordance with the following procedure, see Fig. A2. Phase to earth injection equipment shall not be used for this test.

(i) The signal generator shall be connected between two phases on the LV side of the transformer.

The leads of the signal generator shall be fused and the terminations shrouded.

Where the leads are connected at the transformer links, care shall be taken to ensure that the signal generator is connected to the transformer winding and not inadvertently to Live LV terminals on the distribution board;

(ii) The test signal shall be injected through the transformer LV winding with the HV cable under test having a short between phases at one point only beyond the point of work. A Primary Earth may be used to provide the short between phases;

(iii) At the point of work the detecting surface of the signal receiver shall be applied to every cable. The signal receiver shall be moved along the length of each cable, listening for the definitive signal. In addition the lay of the cores will produce a rise and fall in the received volume of the signal in the cable being identified, this is distinguishable from an induced signal in a cable which will have a constant volume when the receiver is moved along the cable;

(iv) Having identified the cable carrying the injected signal the receiver shall be used to check the area on either side and below the cable to ensure that the signal is not being emitted by an adjacent cable at the side or underneath the identified cable;

(v) Where any doubt remains all other cables in the track shall be identified by use of the appropriate procedure within this Appendix. A separate Sanction for Test shall be issued for each circuit involved.

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FIG A.2

See Front Eng. No. 00194261
3.2.2 33kV cables connected to transformers

In the case of 33kV transformer circuits, cable isolating link chambers are usually provided on the transformers. Such a circuit shall be treated as described in 3.1. The signal may be injected either from the controlling switchgear or from the appropriate link chamber with a phase to phase short (Method 2.1(i)) or if that is not practicable, a phase to earth short [Method 2.1(ii)] applied at the opposite end and beyond the point of work.

It is not necessary to remove the links from the cable isolating link chambers or any other connected transformers. No other earths or shorts shall be applied during the tests, see Figs. A3(a) and A3(b).

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![Diagram A3(a)](image1)

**FIG A 3(a)**

![Diagram A3(b)](image2)

**FIG A 3(b)**

See Pd Doc. No. 00154293
3.3 Open-Circuited, Pot-Ended or Out-of-Use HV Cable

Since it is not normally practicable to inject signals into open-circuited, pot-ended or out-of-use cables, then whenever reasonably practicable all other cables in the same track shall be identified at the point of work by the appropriate signal injection methods described in 3.1 and 3.2.

A separate Sanction for Test is required for each circuit involved.

4 HV Single Core Cables

Single core cables will normally be laid in trefoil and tied together. However when more than one set of single core cables are present in the same track, identification tests as described below shall be carried out to verify that the single cores tied together are part of the same circuit.

Modern single core HV cables are marked with the voltage, e.g. ‘Electric Cable 33000 volts’. Checking these details against the cable records may assist identification.

4.1 HV Single Core Cables other than Transformer Cables

A Sanction for Test shall be issued for the cable section to be identified using Approved phase to phase injection equipment specifically Approved for the purpose in accordance with the following procedure.

(i) Remove the Primary Earth from one end of the cable(s) to be identified and connect a short between two phases, see Fig. A4(a). A Primary Earth shall not be used to provide the short between phases;

(ii) At the other end of the cable(s) to be identified remove the Primary Earth and connect the signal generator phase to phase between the same two phases using Approved test connections, see Fig. A4(a). Apply the test signal to these phases;
(iii) At the point of work the detecting surface of the signal receiver shall be applied to the outer sheath of every cable. No pronounced rise and fall will be obtained when moving the detector along the cores. However when the signal receiver is applied to the cores of the circuit to which the generator is connected, two cores are likely to emit strong signals and the third a significantly weaker signal. One of the signal generator connections shall be changed over to the phase not previously connected to the generator, the short between phases transferred correspondingly and the test repeated, see Fig. A4(b). At the point of work the core which previously emitted the weak signal should now be emitting a stronger signal with one of the other cores emitting a much weaker signal than previously;

(iv) The signal receiver shall be applied to all other cables present, in particular other sets of single core cables in trefoil. Any signals emitted should be much weaker;

(v) Having identified the cores carrying the injected signals, the receiver shall be used to check the area on either side and below the cores to ensure that the signal is not being emitted by adjacent cables at the side or underneath the identified cores;

(vi) The identified core(s) shall then be marked by paint or tape or similar means which will clearly identify the core(s) throughout the course of the work or testing;

(vii) Where any doubt remains, all other cables in the track shall be identified by Approved means. A separate Sanction for Test shall be issued for each circuit involved.

4.2 HV Single Core Transformer Cables where the Cables under Test Cannot be Isolated from a Transformer Winding via Isolating Links

A Sanction for Test shall be issued to include: the cable section to be identified, the transformer and the cable section between the transformer and the lower voltage Point of Isolation. Testing shall be carried out using Approved phase to phase injection equipment specifically Approved for the purpose in accordance with the following procedure:

(i) The signal generator shall be connected between two phases on the lower voltage side of the transformer in accordance with Fig. A5(a);

(ii) The test signal shall be injected through the transformer lower voltage winding with the higher voltage cables under test having a short between phases at one point only beyond the point of work. A Primary Earth shall not be used to provide the short between phases;

(iii) At the point of work the detecting surface of the signal receiver shall be applied to the sheath of every core. No pronounced rise and fall will be obtained when moving the detector along the cores. However if the receiver is applied to the circuit to which the generator is connected one core is likely to emit a strong signal, the second core a weak signal and the third an intermediate signal. The signal strength on each core shall be noted;

(iv) One of the signal generator connections shall be changed over to the phase not previously connected to the generator and the short between phases beyond the point of work transferred to the corresponding phases, see Fig. A5(b);

(v) The test shall be repeated with the new connections in place and at the point of work the detecting surface of the signal receiver shall be applied to the sheath of every core. No pronounced rise and fall will be obtained when moving the detector along the cores. However if the detector is applied to the circuit to which the generator is connected a similar distribution of signal strength should be obtained as before but the core which previously emitted a weak signal should now emit a stronger signal;

(vi) The signal receiver shall be applied to all other cables present, in particular, other sets of single core cables in trefoil. Any signals emitted should be much weaker;
(vii) Having identified the cores carrying the injected signal the receiver shall be used to check the area on either side and below the cores to ensure that the signals are not being emitted by adjacent cables at the side or underneath the identified cores;

(viii) The identified core(s) shall then be marked by paint or tape or similar means which will clearly identify the core(s) throughout the course of the work or testing;

(ix) Where any doubt remains all other cables in the track shall be identified by similar means. A separate Sanction for Test shall be issued for each circuit.
ATTACHMENT – INDUCED VOLTAGE WORKING

This Attachment supplements the requirements of PSSI 5 and shall be applied, as appropriate, for work or testing on power or auxiliary cables where there is a possibility that such cables could be subject to dangerous voltages arising either from induced voltages from parallel circuits or from the passage of high fault currents.

1 Work or Testing on High Voltage Cables Under Induced Voltage Conditions

1.1 The relevant precautions set down in PSSI 5 Sections 8, 12 and 14 shall be observed.

1.2 It is recommended that as many low impedance connections as practicable be established between terminal station earths. Such connections may be by a conductor, sheath and/or metallic cooling pipe of the circuit on which work is being carried out.

1.3 If the work area has no local earth, an earth rod(s) sufficient to provide an Adequate Earth shall be installed adjacent to the point of work and the rod(s) then efficiently connected to a common earth bar. Any subsequent earthing to the cable shall be taken from this bar.

1.4 If any part of the work is to be carried out using Earthed Working, an earth mat, connected to the common earth bar, shall be provided to extend outside the work area at the point of access for a distance of at least one metre. All exposed cable sheaths, metallic pipes, bracings, etc. shall be connected to the common earth bar (see Fig. 1).

1.5 If the work is to be carried out using Insulated Working, the precautions given below shall be applied.

(i) With the exception of the conductors or sheaths to be worked on, all exposed metallic pipes, bracings, etc. within the work area and with which contact is possible, shall be wrapped with suitable insulation and an Insulated Platform provided when required within the work area (see Fig. 2);
(ii) Before using an Insulated Platform, the insulation resistance shall be measured across the supporting insulators connected in parallel. The resistance shall be not less than 10 megohms measured with a 1kV 'Megger';

(iii) In damp environments where it would not be possible to obtain the required insulation level under the prevailing conditions, a dry environment shall be created at the point of work to achieve the required insulation level;

(iv) Under conditions of induced voltage or rise of earth potential, the potential of the work area earth System may rise above that of the local mass of earth. If metallic connections such as cables or pipes extend from within the work area earth System to equipment outside that earth System, a hazard could exist to Persons inside and outside the work area. All such metallic connections shall have an insulating section so that a Person cannot make simultaneous contact with two earth Systems. A typical HV cable joint bay situation is shown in Fig. 3;

FIG. 2

FIG. 3
(v) Metalwork on the work area side of the insulating section shall be connected to the common earth bar. Metalwork on the external side of the insulating section shall be connected to a separate, external earth system;

(vi) External insulation shall be applied to exposed metalwork and pipes near the boundary of the work area earth mat so that Persons in contact with the earth mat cannot make simultaneous contact with metalwork connected to the separate, external earth system. Alternatively, the earth mat near the boundary can be covered with an Insulating Mat;

(vii) Persons carrying out Insulated Working shall not accept materials from, or make physical contact with, any person(s) not in the same insulated environment.

1.6 Electrical supplies into the work area shall be via an isolating transformer.

1.7 Work shall now proceed in accordance with the relevant Scheme.
2 Work on, or Testing at, **Power Cable Sheath Links Boxes Under Induced Voltage Conditions**

2.1 The relevant precautions set down in PSSI 5 Sections 8, 14 and 15 shall be observed.

2.2 In some cases the carcase of a **Cable Sheath Link Box** may be **Earthed** to a local earth and not connected to the earth associated with the cable sheaths. Before work is carried out on the cable sheath disconnecting links and SVL connections in these **Cable Sheath Link Boxes**, the two earths shall be connected together using **Insulated Working**.

2.3 Where the terminal pillars of the **Cable Sheath Link Box** are provided with special connecting points for the attachment of **Bridging Earths**, these **Bridging Earths** shall be applied and removed by means of an operating pole or utilising **Insulated Working**. The cable sheath disconnecting links and SVL connections may be adjusted as required once **Bridging Earths** are applied to all the terminal pillars.

2.4 Where the terminal pillars of the **Cable Sheath Link Boxes** are not provided with special connecting points for attachment of **Bridging Earths**, **Insulated Working** shall be utilised for the application and removal of **Bridging Earths**, the adjustment of sheath disconnecting links, the adjustment of SVL connections or the fitting of an Adaptor Plate (see 6 below).

2.5 Where reasonably practicable, **Cable Sheath Link Boxes** shall be **Locked** after each operation and a **Caution Notice** attached. The **Caution Notice** shall not be removed until work has been completed, the links returned to the normal operating position and the box finally **Locked**.

2.6 Where it is not possible to connect the earth end fitting of the **Bridging Earth** to the earth pillar or to the external connections of the **Cable Sheath Link Box**, the fitting shall be connected to a supplementary earth rod driven as closely as possible to the **Cable Sheath Link Box**.

2.7 Work or testing shall now proceed in accordance with the relevant Scheme.

2.8 Before cancelling the final **Safety Document**, the **Senior Authorised Person** shall satisfy himself that all links and earthing arrangements are returned to the correct operational mode.
3 Work on or Testing of Auxiliary Cables Under Induced Voltage Conditions

3.1 The relevant precautions set down in PSSI 5 Sections 8 and 12 shall be observed.

3.2 Work or testing shall be carried out in accordance with PSSI 12 and a **Senior Authorised Person** shall issue a **Safety Document** or give appropriate instructions on the manner of work or testing.

3.3 For auxiliary cables it is considered impracticable to develop effective means for earthing the conductors which can be guaranteed to sustain the passage of the resulting high value of induced current. Therefore **Insulated Working** shall, where practicable, be applied for work or testing on the conductors except at non-insulated, metallic terminal boxes where a combination of **Insulated Working** and **Earthed Working** may have to be employed.

3.4 Prior to any work or testing on the conductors, **Insulated Working** shall be used to ensure the following:

   (i) At terminations at each end of the section to be worked on, the conductors in that section shall be **Isolated** from the terminal equipment and bonded together if required. Unless the termination is the point of work, a **Caution Notice** shall be displayed and, where reasonably practicable, the terminal box **Locked**;

   (ii) At terminations within the section to be worked on, for example oil/gas points, temperature monitoring positions or outstations associated with water-cooling, the conductor terminations may be left in situ provided a **Caution Notice** is displayed at these positions and, where reasonably practicable, the terminal boxes **Locked**;

   (iii) Depending on the work or testing to be done as detailed in the appropriate Schemes, the relevant precautions set down in 1.3, 1.4 and 1.5 shall be observed;

   (iv) Work or testing shall now proceed in accordance with the relevant Scheme.
4 Work on or Testing of Metallic Cooling Pipes Under Induced Voltage Conditions

4.1 The relevant precautions set down in PSSI 5 Sections 8, 12, 13 and 14 shall be observed.

4.2 A Senior Authorised Person shall issue a Safety Document or give appropriate instructions on the manner of work or testing.

4.3 Using Insulated Working the following additional precautions shall be applied:

(i) The section(s) to be worked on or tested shall be hydraulically Isolated and, where practicable, the appropriate valves Locked and a Caution Notice posted;

(ii) The contents of the pipes shall be adjusted to a level which avoids Danger and where drains could give rise to Danger they shall be Locked in the appropriate position;

(iii) When testing, the pipework insulated couplings at the nearest points on either side of the point of work or test shall be removed or drained as appropriate to achieve electrical isolation (see Fig. 4);

(iv) At bleed valve, turn round and header tank positions within the zone of testing, the insulated valve supports shall be inspected to ensure that the insulators are dry and that the pipes to the valves are free of earth;

(v) The relevant precautions set down in 1.3, 1.4 and 1.5 shall be observed;

(vi) Work or testing shall proceed in accordance with the appropriate Schemes.

FIG. 4
5 Use of Bridling Bar

This section sets down the procedures for using the Bridling Bar for earthing and through bonding of conductors or cable sheaths. The Bridling Bar can be used attached to, or detached from, the Insulated Platform, as required.

5.1 Use of Bridling Bar for Earthing

(i) When using Insulated Working, immediately prior to the application of a Bridging Earth, there could be Danger from the Person holding the earth in one hand and touching, with another part of their body, a conductor or sheath subject to induction. To avoid this, a Bridling Bar attached to, but insulated from, the Insulated Platform provides an intermediate bonding point with the local earth System;

(ii) The Bridging Earth shall first be attached to the conductor or sheath to be Earthed, care being taken to ensure that no part of the Bridging Earth is allowed to come into contact with earth or any other conducting material. The free end of the Bridging Earth is then attached to the Bridling Bar using an Approved operating pole;

(iii) If at this stage the Bridling Bar is not connected to a common earth bar a connection shall be made, the connection first being applied to the common earth bar and then to the Bridling Bar using the operating pole.

This operation shall not be carried out by a Person on the Insulated Platform.

5.2 Use of Bridling Bar for Through Bonding

Using Insulated Working, Bridging Earths shall first be attached to the conductors or sheaths to be bonded, care being taken to ensure that no parts of the Bridging Earths are allowed to come into contact with earth or any other conducting material. The free ends of the Bridging Earths are then attached to the Bridling Bar using the operating pole.

Note: The removal of connections from the Bridling Bar shall be carried out in the reverse order to that in which they were applied.
6 Use of Adaptor Plate

The Adaptor Plate is designed to facilitate the earthing of cable sheaths and the testing of cable sheaths and barrier joints at **Cable Sheath Link Boxes** which do not meet the appropriate requirements. The use of the Adaptor Plate also obviates the need for Triflex Earths.

All operations involved in the fitting, use and removal of the Adaptor Plate shall be carried out under **Insulated Working** conditions using **Approved** insulated tools and operating poles, as appropriate.

6.1 Use of Adaptor Plate for Earthing Cable Sheaths

(i) Before application the Adaptor Plate shall be carefully examined to ensure that it is clean and free of moisture, that all slide bars are secured in the Sheath to Earth position and the lifting attachment is securely fitted;

(ii) After attaching one end of the Uniflex Earth to the Adaptor Plate earthing bar, the free end of the Uniflex Earth shall be connected to the **Cable Sheath Link Box** earth System;

(iii) Disconnect the SVLs from the **Cable Sheath Link Box** pillars;

(iv) Remove all links from the **Cable Sheath Link Box**, place the Adaptor Plate over the **Cable Sheath Link Box** pillars and secure the Plate to the pillar studs. All cable sheaths connected to the **Cable Sheath Link Box** are now **Earthed**;

(v) Use of Adaptor Plate for testing cable sheaths and barrier joints;

(vi) After completing the above procedure, the slide bar connections on the Adaptor Plate may be adjusted as necessary and test voltages applied to the cable sheaths through the Adaptor Plate test bar.
SCHEME 1 – OVERSHEATH AND JOINT BARRIER TESTS ON POWER CABLES

This Scheme supplements the relevant requirements of PSSI 5 to enable testing of oversheaths and joint barriers on power cables.

1 Utilising the appropriate procedures detailed in 2.3 or 3.4 of the PSSI 5 Attachment, the following operations shall be carried out:

   (i) Where cross-bonded or single point bonded Systems are equipped with SVLs they shall be disconnected from the terminal pillars of the minor Cable Sheath Link Boxes of the major section to be tested;

   (ii) The metallic sheaths of the section under test shall then be disconnected from earth at the major Cable Sheath Link Box remote from the point of test by removing the links. The terminal pillars associated with the adjacent major sections shall be Earthed by Bridging Earths in this remote Cable Sheath Link Box. Alternatively, it may be possible to earth these terminal pillars by replacing links in the appropriate position;

   (iii) The links in the Cable Sheath Link Box at the point of test shall then be removed and Bridging Earths applied between earth and all the terminals;

   (iv) Where so desired, the above connections may be made via an Adaptor Plate (see Section 6 of the PSSI 5 Attachment) or an Approved test and earth connection box. Care shall be taken during the initial connecting up stage to ensure that the moveable contacts of the plate or connection box are in the Earthed position and that its earth lead is connected to the earth of the Cable Sheath Link Box or to the supplementary earth rod, as applicable.

2 The metallic sheaths of the section to be tested are now Earthed only at the point of test. These Bridging Earths may be removed, as necessary, only for the duration of the tests. Where an Adaptor Plate or Approved connection box is being used, the change of connection from 'test' to 'earth' and vice versa shall be carried out in accordance with an agreed procedure. Where such a connection box is not being used, the sheaths shall be Earthed before applying or removing test connections or alternatively the test connection shall be applied using Insulated Working.

3 Similar procedures shall be adopted if it is required to test individual minor sections.

   Note: If a voltage is applied to the oversheath of one section, the associated joint barriers will be subjected to the same test voltage provided that the sheaths of the adjacent section(s) are Earthed.

4 When testing to identify sheaths, Insulated Working conditions shall be adopted.
FIG. 1.1
SCHEME 2 – OVERSHEATH REPAIRS TO POWER AND AUXILIARY CABLES AND METALLIC COOLING PIPES

This Scheme supplements the relevant requirements of PSSI 5 to enable oversheath repairs to be carried out on power and auxiliary cables and metallic cooling pipes.

1. Using *Insulated Working*, a section of the oversheath shall be removed.

2. A *Bridging Earth* shall then be applied to the metallic sheath and connected to the common earth bar via the Bridling Bar, using the procedure set down in Section 5 of the PSSI 5 Attachment.

3. Repairs may then proceed under *Earthed Working* conditions.

4. When it is necessary to remove the *Bridging Earth* from the metallic sheath, *Insulated Working* shall be resumed and the work completed under these conditions.

5. If it is impracticable or undesirable to apply the *Bridging Earth* to the metallic sheath at, or close to, the point of work *Insulated Working* shall be adopted throughout the work.

6. When carrying out repairs to auxiliary cables or metallic cooling pipes, any *Bridging Earths* shall be applied to the auxiliary cable sheath and/or armour or to the metallic cooling pipe, as appropriate.
SCHEME 3 – METALLIC SHEATH REPAIRS TO POWER AND AUXILIARY CABLES AND REPAIRS TO METALLIC COOLING PIPES

This Scheme supplements the relevant requirements of PSSI 5 to enable metallic sheath repairs to be carried out on power and auxiliary cables and repairs to metallic cooling pipes.

1. Using Insulated Working, a section of the oversheath shall be removed to expose the metallic sheath.

2. A Bridging Earth shall then be applied to the metallic sheath and connected to the common earth bar via the Bridling Bar, using the procedure set down in Section 5 of the PSSI 5 Attachment.

3. If the continuity of the metallic sheath is to be broken, a second Bridging Earth shall be applied to the metallic sheath such that an earth is positioned either side of the proposed break.

4. Repairs to the metallic sheath may then proceed under Earthed Working conditions both Bridging Earths being maintained until the metallic sheath repair is completed.

5. Repairs to the oversheath shall then be carried out as follows:

   (i) One Bridging Earth may be removed and the oversheath repaired at that point using Earthed Working;

   (ii) Using Insulated Working, the second earth may then be removed and the repair completed.

6. If it is impracticable or undesirable to earth the metallic sheath using Bridging Earths, applied at or close to the point of work and the continuity of the sheath is not to be broken, Insulated Working shall be adopted throughout the work. If necessary, a Bridging Earth shall be used to bond across any proposed break to maintain the continuity of the metallic sheath.

7. When carrying out repairs to auxiliary cables or metallic cooling pipes, any Bridging Earth(s) shall be applied to the auxiliary cable sheath and/or armour or to the metallic cooling pipe, as appropriate.

FIG. 3.1
SCHEME 4 – CUTTING AND CAPPING POWER CABLES

This Scheme supplements the relevant requirements of PSSI 5 for cutting and capping of power cables.

1. Using Insulated Working, a section of oversheath shall be removed to expose the metallic sheath.

2. Bridging Earths shall then be applied to the metallic sheath on both sides of the proposed cut and connected to the common earth bar via the Bridling Bar, using the procedure set down in Section 5 of the PSSI 5 Attachment.

3. The cable shall now be spiked under Earthed Working conditions at the position of the proposed cut using an Earthed spiking device.
4 Two rings of metallic sheath shall be removed from the section between the spiking device and the Bridging Earths and the cable insulation then reduced at these two points to leave 3mm radial thickness.

5 Using Insulated Working, all conductors on each side of the spiking device shall be Earthed using Approved 'G' type Bridging Earths and the procedure set down in Section 5 of the PSSI 5 Attachment.

FIG. 4.3

6 Using Earthed Working the spiking device can now be removed and the cable cut at the prepared position.

7 A short section of insulation shall be removed from each core and all conductors Earthed via the Bridling Bar to the common earth bar.

8 The Approved 'G' type Bridging Earths can now be removed.

FIG. 4.4
9 On the cable end to be capped, the conductor and metallic sheath shall be shorted together using flexible copper braid.

10 The Bridging Earths applied to the conductor shall now be removed and the cable capped. Care shall be taken to ensure that the cap completely covers the shorting braid.

11 If other work is to be carried out immediately, the Bridging Earths connected to the metallic sheath shall remain in position.

12 If the cable is to be left ‘pot ended’, the Bridging Earth connected to the metallic sheath shall be removed using the procedure set down in Section 5 of the PSSI 5 Attachment. The end caps shall then be fully insulated using Insulated Working.
SCHEME 5 – MAKING OR BREAKING DOWN STRAIGHT OR TRIFURCATING JOINTS OR 3-CORE STOP JOINTS INCORPORATING LEAD-THROUGH BUSHINGS ON POWER CABLES

This Scheme supplements the relevant requirement of PSSI 5 for the making or breaking down of straight or trifurcating joints or 3-core stop joints incorporating lead-through bushings on power cables.

1 Prior to commencing jointing operations it shall be ensured that the conductors and metallic sheaths of the cables to be jointed are individually Earthed to the common earth bar via the Bridling Bar using the procedures detailed below. The Bridging Earths used for this purpose shall be threaded through the joint sleeve and end bells as necessary to allow these items to be located over the cable at the appropriate time.

1.1 Where the metallic sheath of the cable is electrically continuous within the work area, the cable shall be prepared and cut in accordance with Scheme 4 (1 to 8).

1.2 Where the metallic sheath of the cable is not electrically continuous within the work area, Insulated Working shall be used to expose a section of metallic sheath on one side of the discontinuity which shall then be Earthed by a Bridging Earth applied to the common earth bar via the Bridling Bar using the procedure set down in Section 5 of the PSSI 5 Attachment. This operation shall then be repeated on the metallic sheath on the other side of the discontinuity.

1.3 If, on a capped cable, the conductors and metallic sheath are not shorted together, the cable shall be prepared in accordance with the principles of Scheme 4 (1 to 8), omitting the spiking.

1.4 If, on a capped cable, the conductor and metallic sheath are shorted together, the cap shall be removed provided the metallic sheath is Earthed. (If the metallic sheath is not Earthed, Insulated Working shall be used to expose a section of the sheath and a Bridging Earth applied using the procedure set out in Section 5 of the PSSI 5 Attachment). A Bridging Earth shall then be applied between the conductor and the Bridling Bar so that the shorting braid between the conductor and metallic sheath can be removed.

2 Providing the conductors are kept Earthed at all times, Earthed Working can now be used up to the application of the insulation.

3 The cable insulation may now be removed as required to enable the ferruling operation to be carried out. An earth may then be applied to the conductor as close as possible to the insulation, using an Approved calliper type Bridging Earth. Other conductor earths may now be removed and the operation can proceed as follows:

![Diagram](image-url)
(i) For Milliken type conductors a Bridging Earth, connected to earth, shall be applied round the ferrule via the compression equipment and the conductors placed as far as possible into the ferrule. The calliper clamp type Bridging Earth may then be removed and the conductor pushed fully home. The ferrule shall then be jointed on to both conductors. If space permits a Bridging Earth, connected to earth, shall be applied to the ferrule and the compression equipment removed. Alternatively, if it is not possible to apply a Bridging Earth to the ferrule with the compression equipment still attached, Insulated Working shall be used to remove the compression equipment and to earth the ferrule with a Bridging Earth using the procedures set down in Section 5 of the PSSI 5 Attachment;

(ii) For other types of conductor, the ferrule shall be jointed on to both conductors with the calliper clamp type Bridging Earths in position. A Bridging Earth shall then be applied to the ferrule and the calliper clamp type Bridging Earths removed.

The insulation and metallic sheaths shall be finally prepared up to the re-insulation process.
5 Temporary insulation shall be applied over the exposed metallic sheaths and clamps. Using Insulated Working the Bridging Earth on the ferrule shall be removed adopting the procedure set down in Section 5 of the PSSI 5 Attachment. Insulation shall then be applied to the conductor up to 3mm radial thickness.

![FIG. 5.4](image)

6 Using Earthed Working, the temporary insulation may be removed and the joint completed up to, and including, plumbing and impregnation.

![FIG. 5.5](image)

7 The joint outer protective box, permanent oil feed lines and bonding leads shall then be fitted in accordance with Scheme 10.

8 When breaking down a joint, the reverse of the procedure detailed above shall be used, as applicable.

9 When making or breaking down a 3-core stop joint incorporating lead-through bushings, this can be done using the procedure detailed above by treating the central barrier and the lead-through bushings as part of the ferrules.
SCHEME 6 – REPAIRING POWER CABLES USING EXTENDED FERRULE REPAIR STRAIGHT JOINTS

This Scheme supplements the relevant requirements of PSSI 5 for the repair of power cables using extended ferrule repair straight joints.

1 Where it has been established that spiking is not necessary (see PSSI 5, 13.8) the following procedure shall be adopted:

1.1 Using Insulated Working, a section of the oversheath shall be removed to expose the metallic sheath.

1.2 Bridging Earths shall be applied to the metallic sheath on both sides of the proposed cut and connected to the common earth bar via the Bridling Bar, using the procedure set down in Section 5 of the PSSI 5 Attachment.

1.3 A ring of metallic sheath shall be carefully removed in the vicinity of the extended ferrule position.

1.4 Continuing with Insulated Working, the cable insulation shall be removed to expose the core and the conductor Earthed each side of the proposed cut using Bridging Earths adopting the procedure set down in Section 5 of the PSSI 5 Attachment.

1.5 Using Earthed Working, the cable can now be cut at the prepared position.

1.6 Jointing can now continue in accordance with Scheme 5.

2 Where positive identification cannot be established, the following procedure shall be adopted:

2.1 The cable shall be spiked at the point of cut only (i.e. the centre line of the extended ferrule) under Earthed Working conditions using an Earthed spiking device, after the cable has been prepared in accordance with 1.1 and 1.2.

2.2 The spiking device shall then be removed.
2.3 A ring of metallic sheath shall be carefully removed in the vicinity of the extended ferrule position and the cable insulation reduced to leave 3mm radial thickness.

2.4 Continuing with Insulated Working, all conductors on each side of the proposed cut shall be Earthed using Approved ‘G’ type Bridging Earths applied as close as possible to the cut position adopting the procedure set down in Section 5 of the PSSI 5 Attachment.

2.5 Using Earthed Working, the cable can now be cut at the prepared position.

2.6 A short section of insulation shall be removed from each core and all conductors Earthed via the Bridling Bar to the common earth bar.

2.7 The Approved ‘G’ type Bridging Earths can now be removed.

2.8 Jointing can now continue in accordance with the relevant requirements of Scheme 5.
SCHEME 7 – MAKING OR BREAKING DOWN SINGLE CORE STOP JOINTS INCORPORATING TWO PLUG-IN CONDUCTOR FITTINGS

This Scheme supplements the relevant requirements of PSSI 5 for the making or breaking down of single core stop joints incorporating two plug-in conductor fittings.

1 Prior to commencing jointing operations on the first cable to be worked on, it shall be ensured that the conductor and metallic sheath of the cable are individually **Earthed** to the common earth bar via the Bridling Bar using the procedure detailed below. The **Bridging Earths** for this purpose shall be threaded through the end bell as necessary to allow this item to be located over the cable at the appropriate time.

1.1 Where the metallic sheath of the cable is electrically continuous within the work area, the cable shall be prepared and cut in accordance with Scheme 4 (1 to 8).

1.2 Where the metallic sheath of the cable is not electrically continuous within the work area, **Insulated Working** shall be used to expose a section of metallic sheath on one side of the discontinuity which shall then be **Earthed** by a **Bridging Earth** applied to the common earth bar via the Bridling Bar using the procedure set down in Section 5 of the PSSI 5 Attachment. This operation shall then be repeated on the metallic sheath on the other side of the discontinuity.

1.3 If, on a capped cable, the conductors and metallic sheath are not shorted together, the cable shall be prepared in accordance with the principles of Scheme 4 (1 to 8), omitting the spiking.

1.4 If, on a capped cable, the conductor and metallic sheath are shorted together, the cap shall be removed provided the metallic sheath is **Earthed**. (If the metallic sheath is not **Earthed**, **Insulated Working** shall be used to expose a section of the sheath and a **Bridging Earth** applied using the procedure set out in Section 5 of the PSSI 5 Attachment). A **Bridging Earth** shall then be applied between the conductor and the Bridling Bar so that the shorting braid between the conductor and metallic sheath can be removed.

2 Provided the conductor is kept **Earthed** at all times, **Earthed Working** can now be used up to and including the application of the insulation and the screen over the profile of the stress cone.

3 The cable insulation may now be removed as required to enable the ferruling operation to be carried out. An earth may then be applied to the conductor as close as possible to the insulation, using an **Approved** calliper clamp type **Bridging Earth**. Other conductor earths may now be removed and the operation can proceed as follows:

   (i) For Milliken type conductors a **Bridging Earth**, connected to earth, shall be applied to the ferrule and the conductors placed as far as possible into the ferrule. The calliper clamp type **Bridging Earth** shall then be removed and the conductor pushed fully home;

   (ii) For other types of conductor, the ferrule shall be jointed on to the conductor with the calliper type **Bridging Earth** in position. A **Bridging Earth**, connected to earth, shall then be applied to the ferrule and the calliper type **Bridging Earth** removed.

4 Work shall now proceed with the application of the insulation and stress cone. During the fitting of the stress cone, either **Insulated Working** or **Earthed Working** can be adopted to suit the jointing operations.
The centre section of the joint, the casing of which shall be **Earthed** to the Bridling Bar, shall be brought up to the end of the cable until the ferrule is on the point of entering the centre section. Using **Insulated Working**, the **Bridging Earth** on the ferrule shall be removed adopting the procedure set out in Section 5 of the PSSI 5 Attachment. The centre section shall immediately be passed over the cable end until the ferrule plugs into the central conductor fitting.

The side of the joint being worked on can then be completed, up to and including plumbing and impregnation, using **Earthed Working**.

The other side of the joint shall be completed using a similar procedure to that detailed above.

The joint outer protective box, permanent oil feed lines and bonding leads shall then be fitted in accordance with Scheme 10.

When breaking down a stop joint of this type, the reverse of the procedure detailed above shall be used, as applicable.
SCHEME 8 – MAKING OR BREAKING DOWN SINGLE CORE STOP JOINTS INCORPORATING A LOCKED AND PLUG-IN CONDUCTOR FITTING

This Scheme supplements the relevant requirements of PSSI 5 for the making or breaking down of single core stop joints, incorporating a locked and plug-in conductor fitting.

1 Prior to commencing jointing operations on the first cable to be worked on which is on the locking side of the joint, it shall be ensured that the conductor and metallic sheath of the cable are individually *Earthed* to the common earth bar via the Bridling Bar using the procedure detailed below. The Bridging Earths for this purpose shall be threaded through the end bell as necessary to allow this item to be located over the cable at the appropriate time.

1.1 Where the metallic sheath of the cable is electrically continuous within the work area, the cable shall be prepared and cut in accordance with Scheme 4 (1 to 8).

1.2 Where the metallic sheath of the cable is not electrically continuous within the work area, *Insulated Working* shall be used to expose a section of metallic sheath on one side of the discontinuity which shall then be *Earthed* by a Bridging Earth applied to the common earth bar via the Bridling Bar using the procedure set down in Section 5 of the PSSI 5 Attachment. This operation shall then be repeated on the metallic sheath on the other side of the discontinuity.

1.3 If, on a capped cable, the conductor and metallic sheath are not shorted together, the cable shall be prepared in accordance with the principles of Scheme 4 (1 to 8), omitting the spiking.

1.4 If, on a capped cable, the conductor and metallic sheath are shorted together, the cap shall be removed provided the metallic sheath is *Earthed*. (If the metallic sheath is not *Earthed, Insulated Working* shall be used to expose a section of the sheath and a Bridging Earth applied using the procedure set out in Section 5 of the PSSI 5 Attachment. A Bridging Earth shall then be applied between the conductor and the Bridling Bar so that the shorting braid between the conductor and metallic sheath can be removed.

2 Provided the conductor is kept *Earthed* at all times, *Earthed Working* can now be used up to and including the application of the insulation and the screen over the profile of the stress cone.

3 The cable insulation may now be removed as required to enable the ferruling operation to be carried out. An earth may then be applied to the conductor as close as possible to the insulation, using an Approved calliper clamp type Bridging Earth. Other conductor earths may now be removed and the operation can proceed as follows:

(i) For Milliken type conductors a Bridging Earth, connected to earth, shall be applied to the ferrule and the conductors placed as far as possible into the ferrule. The calliper clamp type Bridging Earth shall then be removed and the conductor pushed fully home;

(ii) For other types of conductor, the ferrule shall be jointed on to the conductor with the calliper clamp type Bridging Earth in position. A Bridging Earth, connected to earth, shall then be applied to the ferrule and the calliper type Bridging Earth removed.

4 Work shall now proceed with the application of the insulation and stress cone. During the fitting of the stress cone, either *Insulated Working* or *Earthed Working* can be adopted to suit the jointing operations.
The centre section of the joint, the casing of which shall be Earthed to the Bridling Bar, shall be brought up to the end of the cable until the ferrule is on the point of entering the centre section. Using Insulated Working, the Bridging Earth on the ferrule shall be removed adopting the procedure set out in Section 5 of the PSSI 5 Attachment. The centre section shall immediately be passed over the cable end until the ferrule plugs into the central conductor fitting.

The locking ring or nut shall be screwed on to the ferrule using an Approved insulated tool.

The side of the joint being worked on can then be completed, up to and including plumbing and impregnation, using Earthed Working.

The other side of the joint shall be completed using a similar procedure to that detailed above.

The joint outer protective box, permanent oil feed lines and bonding leads shall then be fitted in accordance with Scheme 10.

When breaking down a stop joint of this type, the reverse of the procedure detailed above shall be used, as applicable.
SCHEME 9 – MAKING OR BREAKING DOWN SINGLE CORE STOP JOINTS INCORPORATING A SOLIDLY-FERRULED CONDUCTOR AND A ‘SLIDE-OVER’ CENTRE SECTION

This Scheme supplements the relevant requirements of PSSI 5 for the making or breaking down of single core stop joints incorporating a solidly-ferruled conductor and a ‘slide-over’ centre section.

1 Prior to commencing jointing operations it shall be ensured that the conductors and metallic sheaths of the cables to be jointed are individually Earthed to the common earth bar via the Bridling Bar using the procedure detailed below. The Bridging Earths used for this purpose shall be threaded through the joint sleeve and end bells as necessary to allow these items to be located over the cable at the appropriate time.

1.1 Where the metallic sheath of the cable is electrically continuous within the work area, the cable shall be prepared and cut in accordance with Scheme 4 (1 to 8).

1.2 Where the metallic sheath of the cable is not electrically continuous within the work area, Insulated Working shall be used to expose a section of metallic sheath on one side of the discontinuity which shall then be Earthed by a Bridging Earth applied to the common earth bar via the Bridling Bar using the procedure set down in Section 5 of the PSSI 5 Attachment. This operation shall then be repeated on the metallic sheath on the other side of the discontinuity.

1.3 If, on a capped cable, the conductors and metallic sheath are not shorted together, the cable shall be prepared in accordance with the principles of Scheme 4 (1 to 8), omitting the spiking.

1.4 If, on a capped cable, the conductor and metallic sheath are shorted together, the cap shall be removed provided the metal sheath is Earthed. (If the metallic sheath is not Earthed, Insulated Working shall be used to expose a section of the sheath and a Bridging Earth applied using the procedure set out in Section 5 of the PSSI 5 Attachment). A Bridging Earth shall then be applied between the conductor and the Bridling Bar so that the shorting braid between the conductor and metallic sheath can be removed.

2 Providing the conductors are kept Earthed at all times, Earthed Working can now be used up to the application of the insulation.

3 The cable insulation may now be removed as required to enable the ferruling operation to be carried out. An earth may then be applied to the conductor as close as possible to the insulation, using an Approved calliper clamp type Bridging Earth. Other conductor earths may now be removed and the operation can proceed as follows:

(i) For Milliken type conductors a Bridging Earth, connected to earth, shall be applied round the ferrule via the compression equipment and the conductors placed as far as possible into the ferrule. The calliper clamp type Bridging Earth may then be removed and the conductor pushed fully home. The ferrule shall then be jointed on to both conductors. If space permits, a Bridging Earth connected to earth shall then be applied to the ferrule and the compression equipment removed. Alternatively, if it is not possible to apply a Bridging Earth to the ferrule with the compression equipment still attached, Insulated Working shall be used to remove the compression equipment and to earth the ferrule with a Bridging Earth using the procedure set down in Section 5 of the PSSI 5 Attachment;

(ii) For other types of conductor, the ferrule shall be jointed on to both conductors with the calliper clamp type Bridging Earths in position. A Bridging Earth shall then be applied to the ferrule and the calliper clamp type earths removed.

4 The metallic sheaths shall then be finally prepared and the complete build-up of the cable insulation applied on both sides of the joint.
5 The centre section of the joints, the casing of which shall be **Earthed** to the Bridling Bar, shall be moved along the cable until the ferrule is on the point of being covered by the centre section. Using **Insulated Working**, the Bridging **Earth** on the ferrule shall be removed adopting the procedure set out in Section 5 of the PSSI 5 Attachment. The centre section shall immediately be moved further along the cable until the ferrule registers correctly into the central conductor fitting.

![Diagram](image.png)

**FIG. 9.1**

6 The locking ring(s) or nut(s) shall be screwed on to the ferrule using an **Approved** insulated tool.

7 The joint may be completed up to and including plumbing and impregnation using **Earthed Working**.

8 The joint outer protective box, permanent oil feed lines and bonding leads shall then be fitted in accordance with Scheme 10.

9 When breaking down a stop joint of this type, the reverse of the procedure detailed above shall be used, as applicable.
SCHEME 10 – FITTING JOINT OUTER PROTECTIVE BOXES ON POWER CABLES

This Scheme supplements the relevant requirements of PSSI 5 for the fitting of joint outer protective boxes on power cables.

1 Generally, for joints without bonding leads, Insulated Working shall be adopted for the removal of any Bridging Earths connected to the metallic sheath, and the fitting of the outer protective box. With some joints however, it is possible to pass an earth connection to the joint sleeve through the filling turret whilst the box is being fitted and then remove the Bridging Earths connected to the metallic sheath. In such cases the outer protective box can be fitted using Earthed Working, but Insulated Working shall be used to remove the Bridging Earths connected to the joint sleeve adopting the procedure set down in Section 5 of the PSSI 5 Attachment immediately before filling the box.

2 For joints with bonding leads, Earthed Working may be used to fit the outer protective box provided the sequence of operations given below is adopted and the metallic sheaths are first Earthed by Bridging Earths connected to the joint bay common earth bar.

2.1 Where the Cable Sheath Link Box is installed and the bonding leads are continuous between the Cable Sheath Link Box and the joint sleeve:

(i) Insulated Working shall be adopted to connect a Bridging Earth between the Cable Sheath Link Box permanent earth and the joint bay common earth bar, unless a permanent connection is already installed;

(ii) The bonding leads, and any permanent earth connections, shall then be permanently installed and connected at both ends to the joint sleeve, Cable Sheath Link Box or local earth as appropriate, using Earthed Working.

(iii) Bridging Earths, connected to earth, shall be applied to all terminal pillars in the Cable Sheath Link Box and the earths connected to the metallic sheath removed;

(iv) The installation of the outer protective box may now be completed including permanent oil feed lines, provided an insulated link has first been fitted in these lines;

(v) Insulated Working shall then be used to remove any Bridging Earths applied between the joint bay and Cable Sheath Link Box permanent earths, unless a permanent connection has since been installed in which case Earthed Working may be used.
2.2 Where the *Cable Sheath Link Box* is installed after the joint, or the bonding leads from the joint have not yet been jointed on to existing leads from the *Cable Sheath Link Box*:

(i) A temporary local earth point shall be established at the free end of the bonding leads, remote from the joint sleeve;

(ii) *Insulated Working* shall be adopted to connect a *Bridging Earth* between the local earth at the free end of the bonding leads and the joint bay common earth bar;

(iii) Using *Earthed Working*, all conductors at the free end of the bonding leads shall be temporarily *Earthed* and the conductors at the other end bolted to the connecting lugs of the joint sleeve. The *Bridging Earths* connected to the metallic sheath may then be removed and the installation of the outer protective box completed including permanent oil feed lines, provided an insulated link has first been fitted in these lines;

(iv) *Insulated Working* shall then be used to remove the temporary connection between the local earth at the free end of the bonding leads and the joint bay common earth bar;

(v) Reference shall be made to Schemes 14 and 15 for the procedure when the *Cable Sheath Link Box* is to be installed or the bonding leads jointed.

3 When removing joint outer protective boxes, the reverse of the procedure detailed above shall be used, as applicable.
SCHEME 11 – MAKING OR BREAKING DOWN SEALING ENDS ON POWER CABLES

This Scheme supplements the relevant requirements of PSSI 5 for the making or breaking down of sealing ends on power cables.

1 Prior to commencing jointing operations, it shall be ensured that the metallic sheath of the cable is **Earthed**. Similarly, it shall be ensured that the conductor is **Earthed** prior to work on the core.

1.1 *Insulated Working* shall be used to expose a section of the metallic sheath and then to earth this by a *Bridging Earth* applied to the common earth bar.

1.2 If, on a capped cable, the conductor and metallic sheath are not shorted together the cable shall be prepared in accordance with the principles of Scheme 4 (1 to 8), omitting the spiking.

2 Providing the conductor is kept **Earthed** at the point of work at all times, **Earthed Working** can be used in accordance with the appropriate jointing instructions.

3 Remove the cable insulation as required in preparation for attaching the conductor fitting.

**Approved** conductor calliper clamp type *Bridging Earth* as close as possible to the insulation. Other conductor earths may now be removed and the conductor cut at the appropriate position. The operation may now proceed as follows:

(i) For Milliken type conductors a *Bridging Earth*, connected to earth, shall be applied to the conductor fitting and the conductors placed as far as possible into the conductor fitting. The calliper clamp type *Bridging Earth* shall then be removed and the conductor pushed fully home;

(ii) For other types of conductor, the conductor fitting shall be jointed on to the conductor, with the calliper clamp type *Bridging Earth* in position. A *Bridging Earth*, connected to earth, shall then be applied to the conductor fitting and the calliper type *Bridging Earth* removed.

4 Work shall now proceed in accordance with the appropriate jointing instructions (see Fig. 11.1).

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**FIG. 11.1**
Where possible, during the lowering of the porcelain, a temporary Bridging Earth, connected to earth, shall be passed through it and attached to the conductor (see Fig. 11.2).

When the design of sealing end is such that the clearance between the conductor stalk and the top cap does not permit the passage of an earth clamp, then using Insulated Working the earth can be temporarily removed during the operation of lowering the porcelain into position. The earth shall be replaced as soon as possible but until this is done the Person doing the work shall comply with Insulated Working standards (see Fig. 11.3).

When breaking down a sealing end, the reverse of the procedure detailed above shall be used, as applicable.
SCHEME 12 – REPAIRING OIL AND GAS LEAKS

This Scheme supplements the relevant requirements of PSSI 5 for the repairing of oil and gas leaks.

1 Where leaks develop in metallic sheaths, cable accessories or metallic feed lines between the insulated oil or gas links and the associated joint or sealing end, the work shall be treated as a metallic sheath repair (see Scheme 3).

2 Where leaks occur in metallic feed lines between the insulated oil or gas links and the oil or gas reservoir, Induced Voltage Working will not be required and this Scheme therefore will not apply.
SCHEME 13 – WORK IN CABLE SHEATH LINK BOXES NOT INVOLVING THE CUTTING OR DISCONNECTION OF BONDING LEADS

This Scheme supplements the relevant requirements of PSSI 5 for work in Cable Sheath Link Boxes not involving the cutting or disconnection of bonding leads.

1 The work may be undertaken using one of the methods given below:

1.1 If it is practicable to maintain an earth connection via Bridging Earths or links to all terminals in the Cable Sheath Link Box being worked on, then Earthed Working may be used.

1.2 If it is necessary to remove the earth connection from terminal pillars within the Cable Sheath Link Box being worked on then Insulated Working may be used provided the defined work environment can be maintained.

1.3 If it is not practicable to use either Earthed Working or Insulated Working techniques, then the method of working bare hand detailed below, which embodies the principle of ensuring that at all times there is a connection between earth and the metallic sheath of at least one cable on either side of the point of work, may be used provided the following requirements are first complied with:

   (i) The oversheath and joint barriers on the minor section either side of the Cable Sheath Link Box to be worked on shall be proved (see Scheme 1). Any oversheath or barrier faults shall be located and repaired before proceeding;

   (ii) Using the procedures detailed in 2.3 and 2.4 of the PSSI 5 Attachment:

      (a) The metallic cable sheaths shall be bonded together at the adjacent section bonding boxes or cable terminations on each side of the Cable Sheath Link Box to be worked on. This bond shall be clear of earth and can, in some cases, be achieved by links, for example, in three-phase boxes. In the case of single phase boxes, it will be necessary to achieve bonding together by Approved insulated leads. Caution Notices shall be applied at the bonding positions;

      (b) Bridging Earths, connected to earth, shall be applied to the terminal pillars of at least one bonding lead from either side of the point of work.

2 Work can now proceed on the terminal pillars other than those Earthed as in 1.3(ii)(b) above.

3 During the course of the work the Bridging Earths applied in 1.3(ii)(b) may be removed to allow work on those pillars provided Bridging Earths, connected to earth, are applied to the terminal pillars of at least one other bonding lead either side of the point of work.
SCHEME 14 – REPLACING CABLE SHEATH LINK BOXES BY CUTTING AND JOINTING EXISTING BONDING LEADS

This Scheme supplements the relevant requirements of PSSI 5 for replacing Cable Sheath Link Boxes by cutting and jointing existing bonding leads.

1 The work may be undertaken using one of the methods given below:

1.1 If it is practicable to maintain an earth connection via Bridging Earths or links to all terminals and bonding leads at the point of work at all times, then Earthed Working may be used.

1.2 If it is necessary to remove the Bridging Earths from the terminal pillars or bonding leads at the point of work then Insulated Working may be used provided the defined work environment can be maintained.

1.3 If it is not practicable to use either Earthed Working or Insulated Working techniques, then the method of working bare hand detailed below, which embodies the principle of ensuring that at all times there is a connection between earth and the metallic sheath of at least one cable on either side of the point of work, may be used provided the following requirements are first complied with:

(i) The oversheat and joint barriers on the minor section either side of the Cable Sheath Link Box to be replaced shall be proved (see Scheme 1). Any oversheat or barrier fault shall be located and repaired before proceeding;

(ii) Using the procedures detailed in 2.3 and 2.4 of the PSSI 5 Attachment:

(a) The metallic cable sheaths shall be bonded together at the adjacent section bonding boxes or cable terminations on each side of the Cable Sheath Link Box to be replaced. This bond shall be clear of earth and can, in some cases, be achieved by links, for example, in three-phase boxes. In the case of single phase boxes, it will be necessary to achieve the bonding together by Approved insulated leads. Caution Notices shall be applied at the bonding positions;

(b) If Bridging Earths are not already applied between earth and all the terminal pillars or links of the Cable Sheath Link Box to be replaced, then those shall be applied.

FIG.14.1
2 One of the existing bonding leads between the cable joint and the Cable Sheath Link Box shall be cut at the appropriate place for jointing, and both the inner and outer conductors (on the cable joint side of the cut) shall be connected to the local earth by suitable Bridging Earths (see Fig. 14.2).

3 The other two existing bonding leads shall be cut and the Cable Sheath Link Box removed (Fig. 14.3).

4 The new Cable Sheath Link Box, complete with appropriate lengths of bonding lead, shall be placed in situ. Where the terminal pillars of the Cable Sheath Link Box are not provided with special connecting points for Bridging Earths, the links shall be bolted into their normal operating positions.

5 Straight joints shall be made between the two bonding leads referred to in 3 above and the corresponding leads of the new Cable Sheath Link Box (Fig. 14.4).
Where practicable, *Bridging Earths* shall be applied to the terminal pillars corresponding to the bonding leads just jointed (Fig. 14.5). Where the terminal pillars are not provided with suitable connecting points, *Bridging Earths* shall be connected to all three links.

The remaining bonding lead shall be jointed (Fig. 14.6). Where appropriate, *Bridging Earths* shall be applied to its terminals (Fig. 14.7).

Utilising the procedures detailed in 2.3 and 2.4 of the PSSI 5 Attachment:

(i) The *Bridging Earths* at the point of work shall be removed and the *Cable Sheath Link Box* returned to service;

(ii) Any connections applied under 1.3(ii)(a) shall be removed and the bonding arrangement at the bonding position on each side of the point of work returned to the correct operational mode.

All the *Cable Sheath Link Boxes* shall be *Locked* and any *Caution Notices* removed.

In the case of single phase *Cable Sheath Link Boxes* or single core bonding leads, a similar procedure to that given above shall be adopted, care being taken to ensure that at all times there is a connection between earth and the metallic sheaths of at least one cable on each side of the point of work.
SCHEME 15 – REPLACING CABLE SHEATH LINK BOXES BY BREAKING DOWN EXISTING LINK BOXES

This Scheme supplements the relevant requirements of PSSI 5 for the replacing of Cable Sheath Link Boxes by breaking down existing link boxes.

1 The work may be undertaken using one of the methods given below:

1.1 If it is practicable to maintain an earth connection via Bridging Earths or links to all terminals and bonding leads at the point of work at all times, then Earthed Working may be used.

1.2 If it is necessary to remove the Bridging Earths from the terminal pillars or bonding leads at the point of work, then Insulated Working may be used provided the defined work environment can be maintained.

1.3 If it is not practicable to use either Earthed Working or Insulated Working techniques, then the method of working bare hand detailed below, which embodies the principle of ensuring that at all times there is a connection between earth and the metallic sheath of at least one cable on either side of the point of work, may be used provided the following requirements are first complied with:

(i) The oversheath and joint barriers on the minor section either side of the Cable Sheath Link Box to be replaced shall be proved (see Scheme 1). Any oversheath or barrier faults shall be located and repaired before proceeding;

(ii) Using the procedures detailed in 2.3 and 2.4 of the PSSI 5 Attachment:

(a) The metallic cable sheaths shall be bonded together at the adjacent section bonding boxes or cable termination on each side of the Cable Sheath Link Box to be replaced. This bond shall be clear and can, in some cases, be achieved by links, for example, in three-phase boxes. In the case of single phase boxes, it will be necessary to achieve the bonding together by Approved insulated leads. Caution Notices shall be applied at the bonding positions;

(b) If the phase links are not already removed and Bridging Earths applied to all the terminal pillars of the Cable Sheath Link Box to be replaced, then this shall be carried out along with the disconnection of the SVLs.

FIG. 15.1
2 In the case of underground Cable Sheath Link Boxes, the compound shall be removed by suitable means (Fig. 15.2).

3 The Bridging Earths shall be disconnected from one pair of terminal pillars (on the same bonding lead). The existing bonding lead between the joint and the Cable Sheath Link Box shall be detached from the pillars and removed from the Cable Sheath Link Box.

4 A Bridging Earth shall be connected to the inner and outer conductors of the bonding lead, the earth end fitting having first been connected to a local earth bar or rod external to the Cable Sheath Link Box (Fig. 15.3).

5 The other two existing bonding leads between the joints and the Cable Sheath Link Box shall be dealt with as in 3 above (Fig. 15.4).

6 The Cable Sheath Link Box shall be removed and the new box installed.

7 The two bonding leads referred to in 5 above shall be connected into the new Cable Sheath Link Box and Bridging Earths attached between earth and their terminal pillars (Fig. 15.5). Where the terminal pillars of the Cable Sheath Link Box are not provided with special attachment points for Bridging Earths, the link that is common to these two bonding leads shall be fitted and Earthed by means of a Bridging Earth.
The earths shall be removed from the bonding lead referred to in 4 above and the lead connected into the new Cable Sheath Link Box (Fig. 15.6). Bridging Earths shall be attached between earth and the corresponding terminal pillars (Fig. 15.7). Where the terminal pillars of the Cable Sheath Link Box are not provided with special attachment points for Bridging Earths, the remaining two links shall be fitted and Earthed by means of Bridging Earths.

FIGS. 15.6 AND 15.7

The Cable Sheath Link Box shall then be completed as required.

Utilising the procedures detailed in 2.3 and 2.4 of the PSSI 5 Attachment:

(i) The Bridging Earths at the point of work shall be removed and the Cable Sheath Link Box returned to service;

(ii) Any connections applied under 1.3(ii)(a) shall be removed and the bonding arrangement at the bonding position on each side of the point of work returned to the correct operational mode.

All the Cable Sheath Link Boxes shall be Locked and any Caution Notices removed.

In the case of single phase Cable Sheath Link Boxes or single core bonding leads, a similar procedure to that given above shall be adopted, care being taken to ensure that at all times there is a connection between earth and the metallic sheath of at least one cable on each side of the point of work.
SCHEME 16 – CUTTING AND CAPPING AUXILIARY CABLES

This Scheme supplements the relevant requirements of PSSI 5 for the cutting and capping of auxiliary cables.

1. **Insulated Working** shall be used throughout this Scheme.

2. At terminations at each end of the section to be worked on, all conductors shall be **isolated** from their terminal equipment.

3. A section of oversheath shall be removed to expose the metallic sheath and/or armour.

4. **Bridging Earths** shall then be applied to the metallic sheath and/or armour on both sides of the proposed cut and connected to the common earth bar via the Bridling Bar, using the procedure set down in Section 5 of the PSSI 5 Attachment.

5. A section of metallic sheath and/or armour shall be removed without disturbing the conductor insulation. The exposed ends of the metallic sheath and/or armour, together with the bonding clamps, shall be temporarily insulated.

6. The cores shall be cut one at a time. After each cut the core ends shall be moved well apart to avoid accidental contact or alternatively the core ends may be insulated by a cap or other suitable means. This procedure shall be followed until all the cores have been cut.

During this process personal contact shall not be made with more than one conductor at any one time; this includes avoiding the simultaneous touching of the two ends of a conductor after it has been cut (Fig. 16.3).
7. The temporary insulation shall be removed from the metallic sheath and/or armour and associated clamp(s) on one of the cable ends only (Fig. 16.4).

8. The *Bridging Earth* on the cable end shall be disconnected from the Bridling Bar using the procedure set down in Section 5 of the PSSI 5 Attachment and then removed from the metallic sheath and/or armour (Fig. 16.5).
9 The cable sheath shall be capped and all the exposed metallic sheath and/or armouring, including any metal cap, shall be fully insulated.

10 The procedure detailed in 7 to 9 above shall be repeated for the other cable end, if applicable.
SCHEME 17 – JOINTING AUXILIARY CABLES

This Scheme supplements the relevant requirements of PSSI 5 for jointing of auxiliary cables.

1. *Insulated Working* shall be used throughout this Scheme.

2. At terminations at each end of the section to be worked on, all conductors shall be *Isolated* from their terminal equipment.

3. *Any Bridging Earth* used to earth the metallic sheath and/or armour of the cables to be jointed shall be threaded through the joint sleeves as necessary to allow these items to be located over the cable at the appropriate time.

4. Where the metallic sheath and/or armour is electrically continuous within the work area, the cable shall be cut and prepared in accordance with Scheme 16 (4 to 6).

5. Where the metallic sheath and/or armour is not electrically continuous within the work area:
   
   (i) A section of oversheath shall be removed on one side of the discontinuity to expose the metallic sheath and/or armour which shall then be *Earthed* by a *Bridging Earth* applied to the common earth bar via the Bridling Bar using the procedure set down in Section 5 of the PSSI 5 Attachment. This operation shall then be repeated, if necessary, on the metallic sheath on the other side of the discontinuity.

   (ii) A section of metallic sheath and/or armour shall be removed from each cable without disturbing the conductor insulation. The exposed ends of the metallic sheath and/or armour, together with the bonding clamps, shall be temporarily insulated (Fig. 17.2).

![Diagram of jointing auxiliary cables](image-url)
Jointing can now proceed ensuring that only one core from one cable is handled at any one
time. During each ferruling operation one of the two cores being jointed shall be held with
Approved insulated pliers. Each completed ferrule shall be insulated before proceeding with
the next ferruling operation (Fig. 17.3).

After connecting all the cores, the joints shall be completed by connecting through the metallic
sheath(s) and/or armour(s), after which the Bridging Earths shall be removed and the outer
protective box applied or oversheath repair made as necessary (Fig. 17.4).
SCHEME 18 – GLANDING-OFF AUXILIARY CABLES AT TERMINAL BOXES

This Scheme supplements the relevant requirements of PSSI 5 for the glanding-off of auxiliary cables at terminal boxes.

1. **Insulated Working** shall be used throughout this Scheme.

2. A section of oversheath shall be removed to expose the metallic sheath and/or armour.

3. A **Bridging Earth** shall then be applied to the metallic sheath and/or armour and connected to the common earth bar via the Bridling Bar, using the procedure set down in Section 5 of the PSSI 5 Attachment (see Fig. 18.1).

4. A section of metallic sheath and/or armour shall be removed from the cable without disturbing the conductor insulation. The individual conductor ends shall be insulated to prevent accidental contact (Fig. 18.2).
The cable shall be glanded-off and the permanent sheath and/or armour earth connection made (Fig. 18.3).

The Bridging Earth connected to the metallic sheath and/or armour can now be removed and the oversheath repaired.
SCHEME 19 – TERMINATIONS IN FULLY INSULATED BOXES

This Scheme supplements the relevant requirements of PSSI 5 for termination of auxiliary cables in fully insulated boxes.

1. *Insulated Working* shall be used throughout this Scheme.

2. Prior to terminating any core it shall be ensured that any existing connections to off-going equipment are *isolated* on their terminals.

3. Each core can now be terminated individually on to its own terminal. Care shall be taken to ensure that no contact is made between any two cores and/or terminals. In fully *isolated* metallic boxes, special care shall be taken to prevent the conductor touching the metal case.
SCHEME 20 – TERMINATIONS IN NON-INSULATED METALLIC BOXES

This Scheme supplements the relevant requirements of PSSI 5 for the termination of auxiliary cables in non-insulated, metallic boxes.

1 Prior to commencement of work on the conductors, the core to earth insulation resistance of all cores shall be checked (see Scheme 23). The insulation resistance per core shall not be less than the equivalent of 1 megohm for each 1,000 metres. If the insulation resistance per core is less than this value, then:

(i) The fault shall be located and repaired prior to continuing the operation;
(ii) The operation can proceed providing all work is carried out using Insulated Working.

2 At the remote end of the cable from the point of work, all conductors shall be bonded together and insulated from the metallic sheath and from earth using Insulated Working and a Caution Notice displayed.

3 Using Insulated Working, one core shall be connected to earth at the point of work.

4 Insulated Working may now be dispensed with providing at all times while work is being carried out at least one core is connected to earth at the point of work.

5 Using Insulated Working, the final earth shall be removed from the point of work and the connections restored to normal at the remote end.
SCHEME 21 – GENERAL COMMISSIONING TESTS ON AUXILIARY CABLES

This Scheme supplements the relevant requirements of PSSI 5 for general commissioning tests on auxiliary cables.

1  Insulated Working shall be adopted for all general commissioning tests on auxiliary cables.

2  Test equipment and instruments which are to be connected to auxiliary cable cores shall be insulated from earth by placing them on an Insulated Platform or Insulating Mat. An isolating transformer shall be interposed between the test equipment and any mains or other power supply.

3  Auxiliary cable cores shall not be used for temporary telephones unless special arrangements have been made to provide the necessary insulation level, that is, isolating transformers.
SCHEME 22 – OVERSHEATH TESTING ON INSULATED SHEATHS OF AUXILIARY CABLES

This Scheme supplements the relevant requirements of PSSI 5 for oversheath testing on insulated sheaths of auxiliary cables.

1  Insulated Working shall be adopted on disconnecting links and links in Cable Sheath Link Boxes until such times as an Adequate Earth has been applied.

2  Insulated Working shall be used to ensure that the section under test is Earthed only at the point of test and that any adjacent section(s) are Earthed at each end adjacent to the section under test.

3  Insulated Working shall be used to remove the earth from the metallic sheath under test for the duration of such tests but the section shall be Earthed before applying or removing testing connections.

4  When testing to identify sheaths or to locate faults, Insulated Working shall be adopted.
SCHEME 23 – DIELECTRIC TESTS ON AUXILIARY CABLES

This Scheme supplements the relevant requirements of PSSI 5 for dielectric tests on auxiliary cables.

1. *Insulated Working* shall be adopted on disconnecting links and links in *Cable Sheath Link Boxes* until such time as an *Adequate Earth* has been applied.

2. The metallic cable sheaths of the section under test shall be *Earthed* at the terminations at each end of the section.

3. *Insulated Working* shall be used to isolate the conductors under test from their terminal equipment and to earth them at the point of test only.

4. The earth(s) can be removed for the duration of the test, but the conductors shall be *Earthed* before applying or removing test connections.

5. When testing to identify sheaths or to locate faults, *Insulated Working* shall be adopted.