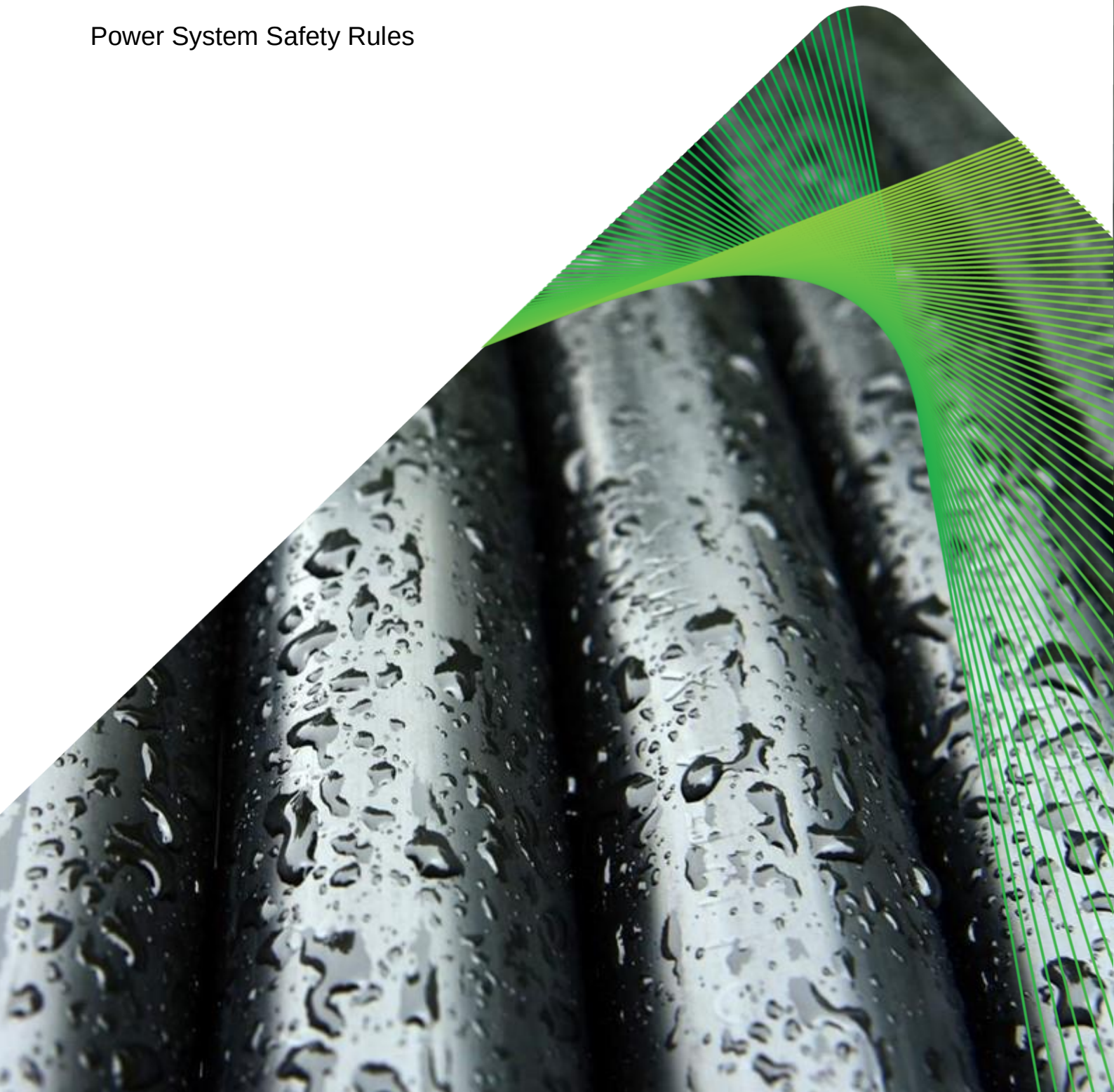
Transgrid

People. Power. Possibilities.

Transmission Cables

Safe Work Handbook

Power System Safety Rules



This Handbook covers the Power System Safety Rules requirements for working on Transmission Cables. The handbook aims to help you be a safe worker and gain your authorisation to work on Transgrid's High Voltage (HV) network.

It has been written in plain, easy to understand language and is a working interpretation of the Power System Safety Rules, known to everybody as the PSSR.

The PSSR and this handbook are reviewed and updated periodically. Check our website at https://www.Transgrid.com.au/working-at-Transgrid/workplace-safety for the latest information.

In this handbook, the words ‘must’ or ‘must not’ are used for rules that you have to follow. The words ‘should’ or ‘should not’ are used when explaining safe and low-risk work practices.

Document Control					
Revision no:	IN REVIEW	HP TRIM no:	0	Approval/ Review date:	[Insert Date approved]
Business function:	Health, Safety & Environment			Document type:	Handbook
Process owner:	GM/Health, Safety & Environment				
Author:	J Mason, PSSR Lead/Health Safety & Environment				
Reviewers:	Mark Dorahy, Cables Team Leader Chris Kezik, Program Services Lead				
Approver:					

Introduction

The Substation and HV Area Handbook covers the Power System Safety Rules (PSSR) you need to know to work safely on Transmission Cables. It's essential reading for anyone working on Transgrid's High Voltage (HV) network. It aims to prepare you for the HV network environment and reduce your risk when working in hazardous areas or situations.

This handbook is the main resource to get your Transmission Cable authorisation via the Worker Safety Authorisation and Training (WSAT) system. It supports training courses, which you must pass to get your worker authorisation.

Read this handbook to check the rules, understand your responsibilities and learn safe working behaviour.

There are also similar handbooks for Substations, Transmission Lines, Low Voltage Mechanical, Mobile Plant and Field Operations and more available at www.Transgrid.com.au/working-at-Transgrid/workplace-safety.

In this handbook, the words 'must' or 'must not' are used for rules that you have to follow. The words 'should' or 'should not' are used when explaining safe and low-risk work practices.

Remember, we all have a responsibility to work safely and look out for each other.

Contents

Introduction **2**

Authorisations **4**

Personal Protective Equipment (PPE) **5**

Power System Notices **6**

Hazard Awareness and Control **8**

Transmission Cables General **9**

Power System Access **16**

Working under a Cable Access Authority **17**

Receipt of a Cable Access Authority **24**

Receipt of a Cable Testing Access Authority **29**

Issue Cable Access Authority **31**

Identification of Transmission Cables and Pilot Cables **33**

Safe Work Methods **35**

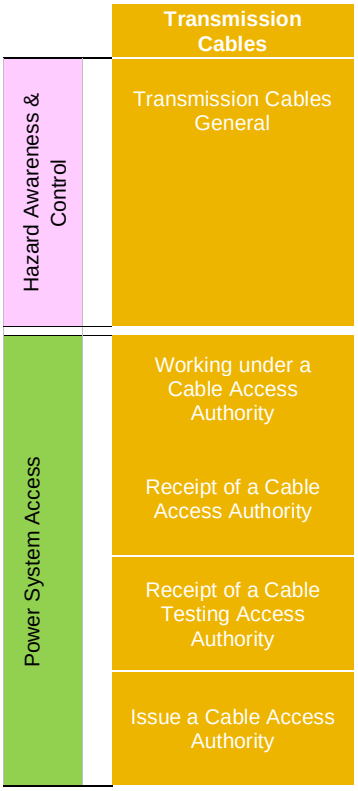
Routine Maintenance **36**

Non-Routine Maintenance **37**

Appendices **45**

Safe Approach Distances to Exposed Conductors **56**

Authorisations



The Power System Safety Rules (PSSR) authorisations are permissions to access an area, perform a type of work, apply a specific control, or execute a controlled process. Persons whose intended work duration is more than 3 days cumulative over 12 months should be authorised under the PSSR.

Getting your PSSR authorisation is a journey and depending where you will be working on our High Voltage Network, you might get one authorisation or many.

There are authorisations for Transmission Cables, Transmission Cables, Low Voltage Mechanical, Mobile Plant and Field Operations and more that can be found in the PSSR Authorisation Structure.

A PSSR authorisation gives you access to work but also brings responsibility. It's a commitment between you and Transgrid to work safely and look out for each other.

For Transmission Cables, it starts with Hazard Awareness and Control, before stepping up to Power System Access. To help build understanding, authorisations and related training courses are in small modules that match the authorisation table shown here. You must be assessed competent in an authorisation before you can move onto the next level.

To work in switchyards and other High Voltage (HV) areas, additional authorisation at Substation – Work in HV Areas is required.

Apprentices and trainees can also get PSSR authorisation but must not be left to work unsupervised in a hazardous area.

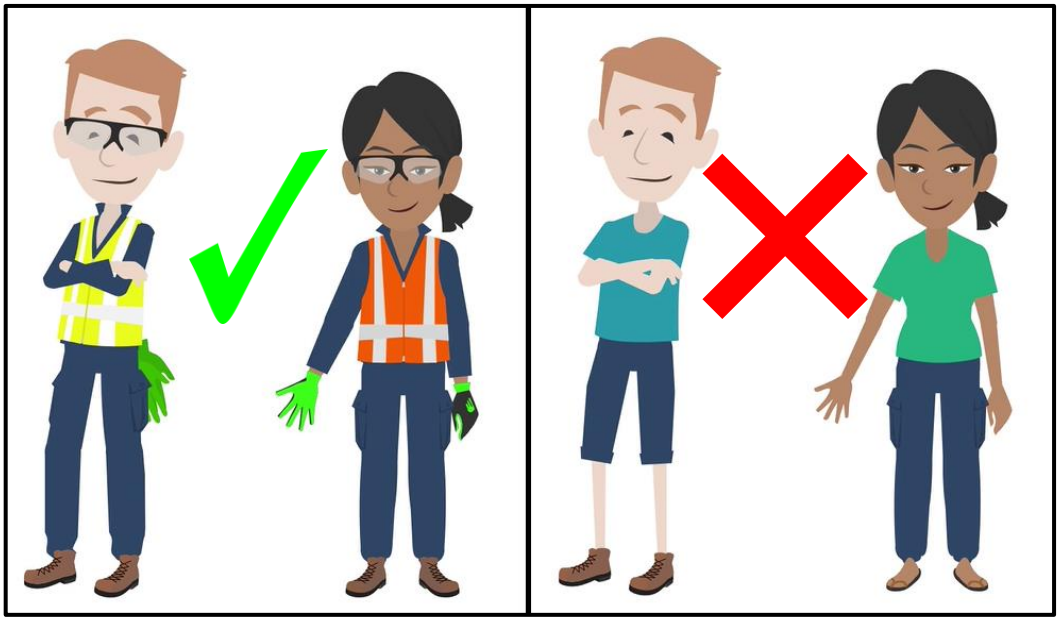
When you get your authorisation, do not abuse, or misuse it. If you do, you may lose your authorisation and access to work at Transgrid.

If you are unsure of how to apply the PSSR correctly, STOP and seek assistance from one of our Safety team before doing your work.

Personal Protective Equipment (PPE)

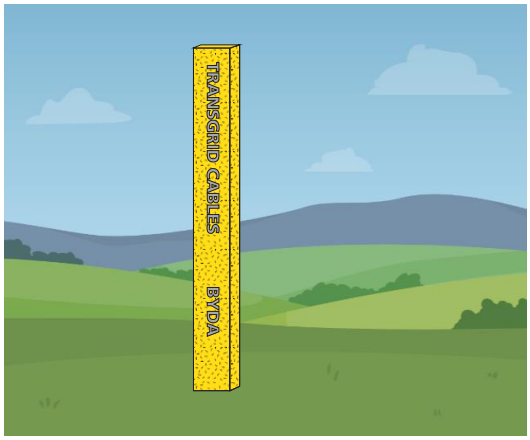
As a minimum you need to wear the following PPE to work on Transgrid Transmission Cables:

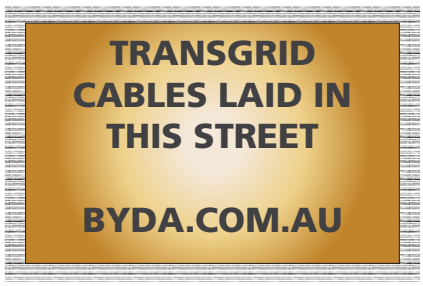
- Long sleeve shirt
- Long trousers
- High visibility shirt or vest
- Safety footwear
- Safety eyewear
- Protective gloves (on clip)

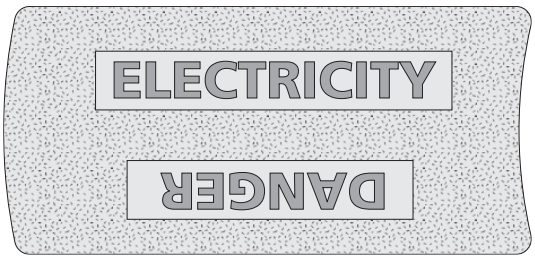


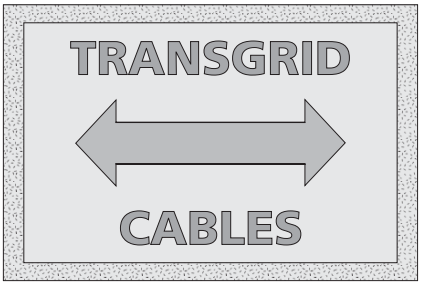
Power System Notices

Signs and tags identify entry requirements, hazardous areas, or conditions.

<table>
<tr><td> 
</td><td>Transmission Cable, or cable destination nameplate, usually affixed to the Transmission Cable at the HV area connection point. Will show the voltage of the conductors.</td></tr>
<tr><td> 

Cable marker post</td><td rowspan="4">Various indicators are used to identify the location of underground Transmission Cables.</td></tr>
<tr><td> 

Kerbside marker</td></tr>
<tr><td> 

Below ground concrete slabs</td></tr>
<tr><td> 

Plaque in non-road areas</td></tr>
</table>

	Transmission Cable pits are identified by feeder designation and e.g. 41/24 where 41 refers to the Transmission Cable and 24 refers to the pit.
	This tag is used to warn of a particular hazard or temporary condition and allows limited operated by specifically authorised persons.
	This tag is used to warn that the operation of the device or equipment to which the tag is attached is likely to be life threatening.

Hazard Awareness and Control

Transmission Cables
General

Transmission Cables General

General work on and in the vicinity of Transgrid owned and managed Transmission Cables is performed by persons authorised Transmission Cables General.

Hazards

Before starting any work, a prestart hazard assessment must take place. At a minimum, the following hazards must be considered, and appropriate safety controls implemented.

7.1.1. Cable Earthing and Sheath Connections

Power System faults can cause hazardous touch and step potentials (voltages) which the Transmission Cable earthing system is designed to manage.

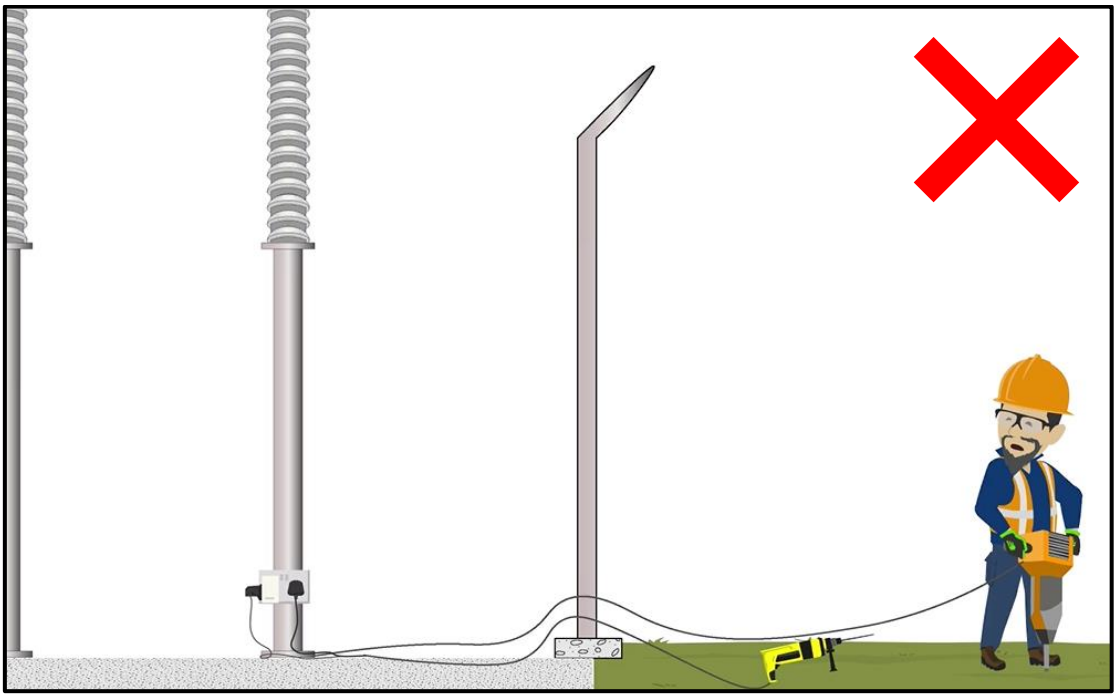
7.1.1.1. Damage

If the Transmission Cable earthing system is damaged hazardous touch potentials may occur between a Transmission Cable and the surrounding ground.

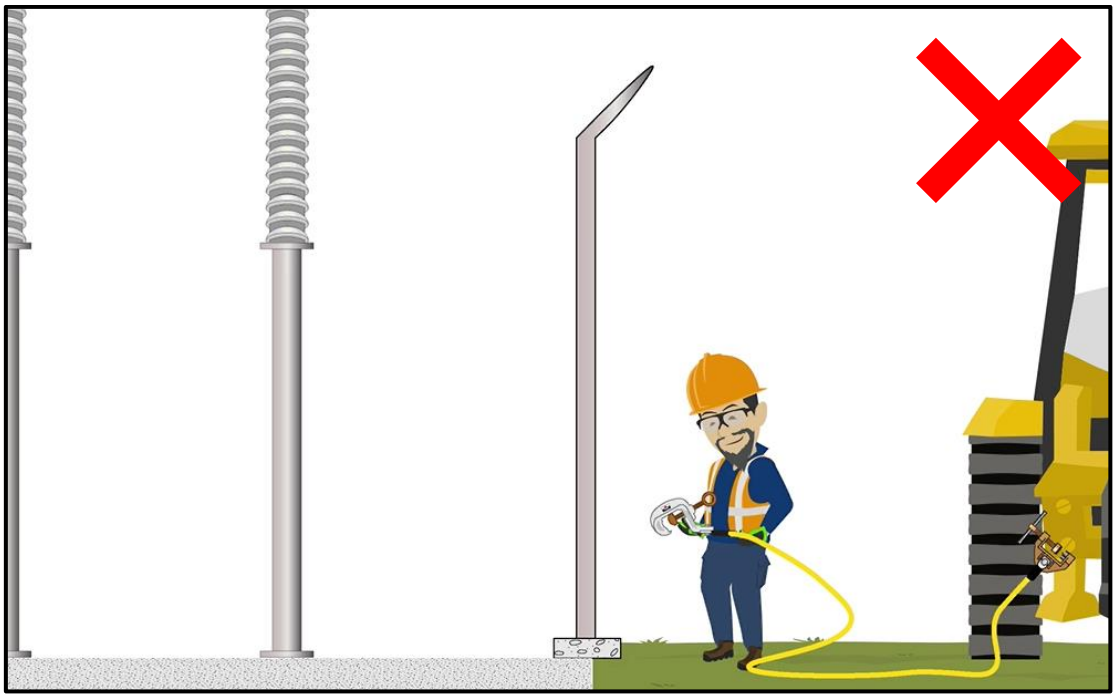
- Any damage to earthing systems must be reported immediately.
- Do not approach, touch or attempt repairs.
- Where work includes the connection, cutting, disconnection or potential to break or damage the cable earthing system, then prior to the work commencing a Cable Access Authority must be issued.

7.1.2. Switchyard Earth Grid Voltage Rise & Transferred Earth Potentials

Substations may be subject to dangerous rises in voltages due to faults in the Power System. Any external connection to a switchyard provides a means for dangerous earth potentials (voltage) to be transferred to or from a substation's earthing grid.



When working outside of the substation fence, you must not connect any of your equipment or mobile plant to the fence or to equipment within the substation.



7.1.2.1. Pilot Cables

Pilot cables are used for control, protection, signalling, telecommunications and data transmission purposes associated with power transmission systems. Work on pilot cable systems and cabinets requires either a LV/MECH Access Authority to be issued or insulated work methods to be used.

7.1.2.2. Installation of Transmission Cables and Pilot Cables

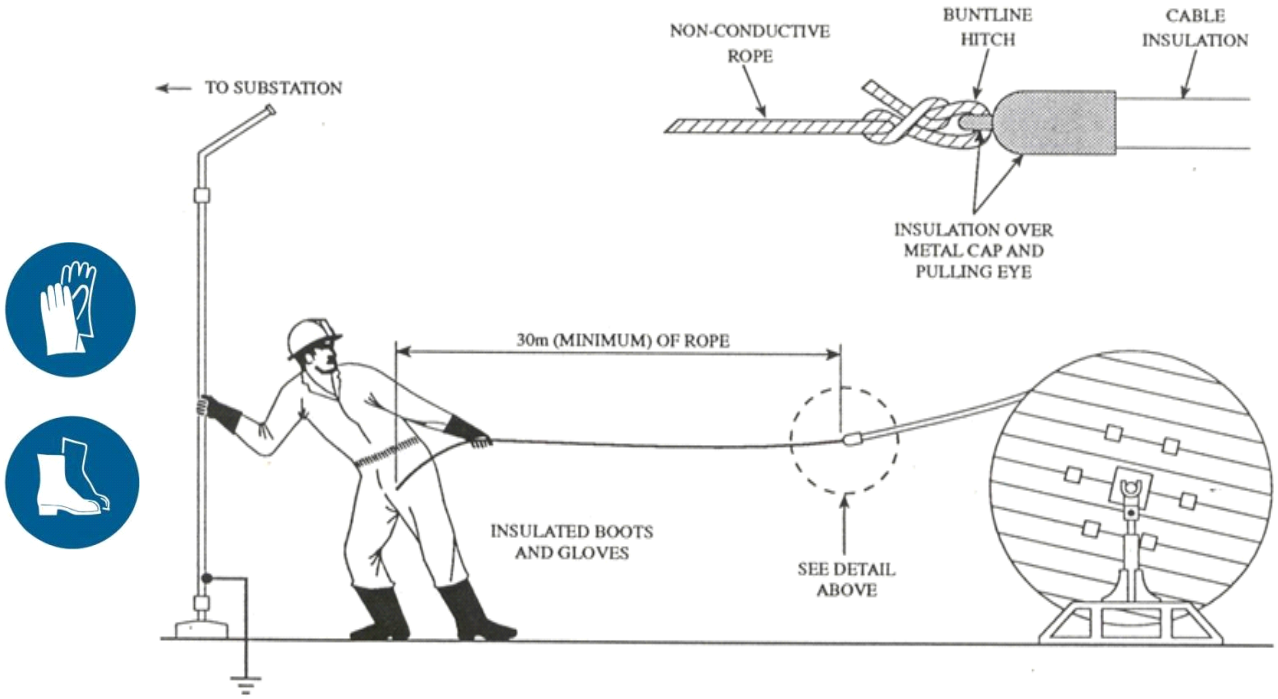
Prior to any new connection like a Transmission Cable being made to a substation, an Electrical Engineer's assessment must determine specific safety controls that must be implemented onsite by the project team and should consider the following work methods.

Positioning of Oil Plants

Where oil plants (or similar items of equipment) are connected to sealing ends or other parts of a cable in a switchyard, then such plants should preferably be located on the switchyard earth mat or, if this is impractical, the oil lines (or other components reaching into the earth mat area) must be provided with an insulating piece, capable of withstanding 17kV ac separating the equipment outside the earth mat area from that within.

Pulling of Transmission Cables and Pilot Cables

When pulling a cable between a live high voltage area and an external joint bay it is essential that precautions, such as those listed below, are taken to prevent transfer of potential.



Pulling Cable into Substation

(a) Bare conductive equipment such as steel wire ropes must not be used within 30 meters of the substation earth mat.

(b) Due to the presence of a conducting graphite coating on power and pilot cables, workers must work under insulated conditions, i.e. suitably approved insulated footwear and gloves must be worn and care must be taken to ensure that the cables does not come into contact with exposed parts of the body.

Pulling must be carried out by one of the following methods or alternatively a specific work method developed for the work which controls transfer potential risks:

Method 1:

The cable drum must be set up in a position not less than 30 metres from the high voltage boundary fence and the cable pulled in a direction away from the fence using conventional equipment and methods. When just sufficient cable is left on the drum to reach the station sealing end pulling must cease.

Method 2:

The cable can be pulled towards and into the high voltage area providing a suitably sized non-conductive rope is used in the area extending 30 metres from the boundary fence and provided all exposed metallic parts are insulated to withstand 17kV ac.

Method 3:

The cable drum must be set up inside the substation area and the cable pulled to a distance not less than 30 metres beyond the high voltage boundary fence using a suitable sized non-conductive minimum stretch rope. Any exposed metallic parts on the nose of the cable must be fully insulated to withstand 17kV ac.

At the 30-metre point a steel wire rope may be used to complete the pull provided that at least 2 metres of non-conductive rope is used between the cable pulling eye and the steel wire rope and the metallic parts on the nose of the cable are fully insulated to withstand 17kV ac.

First Joint Bay-Insulation of Cable Metallic Parts

The cable metallic parts and all oil supplies to the cable must be fully insulated in the first joint bay external to the high voltage area as soon as practicable after the cable pulling and before the insulation is removed from the end of the cable within the high voltage area.

To ensure the adequacy of the applied insulation and the absence of damage to the cable sheath, a serving test of 17kV ac must be applied between the cable sheaths.

Cable Sealing Ends – Working Methods

The cable must be terminated in the cable sealing ends working under either insulated working conditions or bonded earth mat conditions as determined by an engineering assessment.

Cable Sealing Ends – Isolation from Substation Earth

On completion of terminating the sealing ends and where further work is to be performed in remote joint bays, the following conditions must be established at the sealing ends.

The sealing end cap and the cable metallic sheath must be bonded together and insulated from the high voltage area earth grid by sufficient insulation to withstand 17kV ac.

Warning signs must be fixed to the sealing end support structures warning of the possible existence of capacitive voltages and directing that the sealing ends must not be connected to earth or the high voltage system.

Note: The sealing end can still be considered as disconnected apparatus, provided sufficient insulation, delineation and labelling is provided.

Field Jointing

Working methods will depend on field conditions and will be determined by the engineer in charge. When a section of the cable has been connected to a terminal station all further work on that section must be carried out in accordance with Section 0.

Pilot Cable Terminations and Jointing

All field jointing must preferably be carried out before the ends are terminated within the high voltage area. During this operation, the ends within the high voltage areas must have all metallic parts insulated to withstand 17kV ac and field jointing must be carried out under insulated working conditions.

Terminating within the high voltage areas must be carried out in accordance with Section 0. If termination of the pilot is required in advance of jointing along the route, then termination must be made in accordance with Section 0 and all subsequent jointing must be carried out as detailed in Section 0.

7.1.3. Capacitance Associated with Transmission Cables

Transmission Cables may have significant capacitance. This apparatus is able to retain an electrical charge of sufficient magnitude to be hazardous to persons even after the apparatus has been isolated from the source of supply. Transmission Cables must always be fully discharged using a suitable means of earthing before approaching, or working on or near the apparatus, and before working on the apparatus after electrical testing has been performed.

7.1.4. Buried services

When completing any excavations on transmission cable easements, including potholing you must lodge a Before-You-Dig enquiry to identify other services in the area.

7.1.5. Cable work not requiring a Cable Access Authority

Work may be carried out on or in the vicinity of a cable or its associated equipment without a Cable Access Authority where the work involves:

(a) Excavation above the protective slab level or above the concrete encasement layer if slabs are not present;

(b) No risk of persons making direct contact with the metallic cable sheath or armouring of the cable;

(c) Minor work or repairs involving the serving of a cable by methods that avoid direct contact with the metallic cable sheath or armouring;

(d) Work on gas or oil pressure systems, provided oil or gas pressures are maintained and there is no danger to persons from induced voltages or transferred earth potentials;

(e) Insertion of test instruments in bonding or earthing connections provided electrical continuity of the bond or earth is maintained and insulated working methods are used; or

(f) Using permanently or temporarily applied monitoring equipment on the cable surface, such as capacitively coupled partial discharge foils which require the cable energised for testing.

Power System Access

Working under a Cable Access Authority

Receipt of a Cable Access Authority

Receipt of a Cable Testing Access Authority

Issue Cable Access Authority

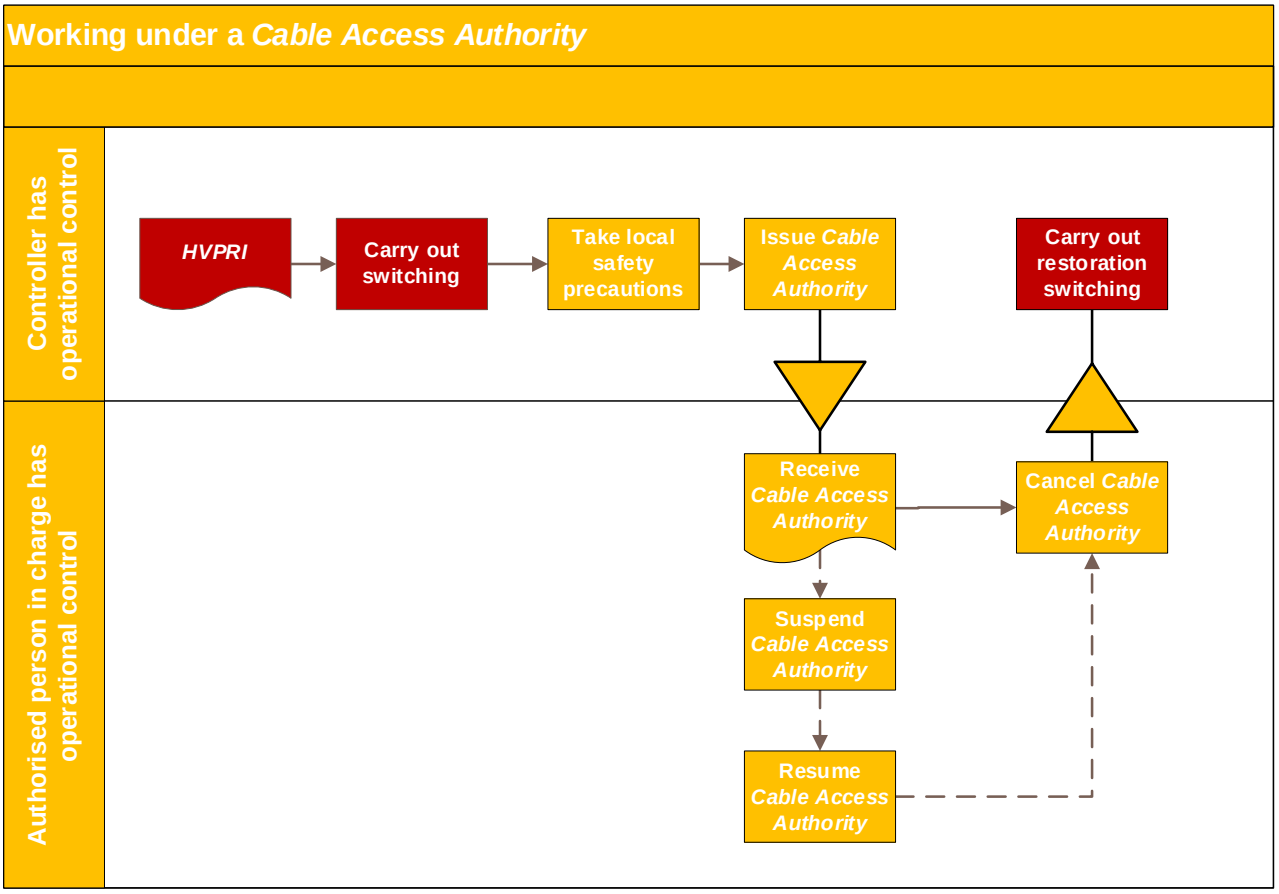
Working under a Cable Access Authority

A Cable Access Authority is required when work, other than that listed in Cable work not requiring a Cable Access Authority, is to be performed on a HV transmission Cable in the charge of a Controller. A Cable Access Authority is issued to provide a safe working environment for personnel when working on or near exposed conductors.

A Cable Access Authority can provide access to any portion of the cable and associated equipment as described on the RFA, including the section inside the switchyard fence and the sealing ends.

Cable Access Authority Flow Chart

The following diagram illustrates the points at which operational control transfers from the Controller to the Authorised person in charge (i.e., the holder of the Cable Access Authority).



7.2. Responsibilities of persons working under a Cable Access Authority

When working under a Cable Access Authority you must:

- Be authorised Working under a Cable Access Authority or work as an instructed person.

- Be shown how the Transmission Cable conductors to be accessed have been made safe for work and given relevant warnings.

- Sign onto the Cable Access Authority to indicate that you understand the warnings and demonstrations given and your responsibilities under the Cable Access Authority.

- Follow any safety directions given by the authorised person in charge (APIC).

- If you temporarily leave the work area, check with the APIC or in their absence another person signed on the Cable Access Authority, that you are at the correct work area before recommencing work.

- Sign off the Cable Access Authority at the completion of your work for each day, shift or when leaving site.

- Before recommencing work at the start of each day or shift (or when returning to site), verify that the conditions of the Cable Access Authority covering the apparatus are still valid before signing onto the Cable Access Authority.

7.2.1. Work Areas

To clearly define a safe working environment, work areas associated with a Cable Access Authority should be setup by a person authorised Issue Cable Access Authority.

7.2.2. Safe working principles

(a) When working on a Transmission Cable conductor (including a metallic sheath, armouring, oil line, etc.), which can be subject to dangerous voltage rise, 'bonded earth mat working conditions' should preferably be employed. Where this is not possible, 'insulated working conditions' must be adopted.

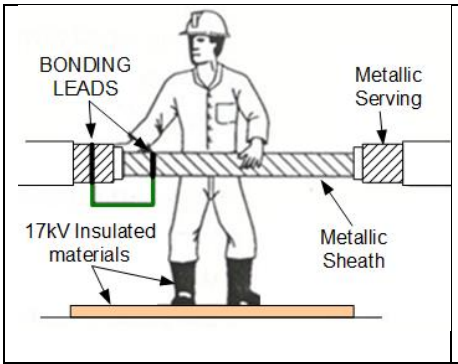
> **Insulated Working Conditions**
>
> Due to the practical difficulties in maintaining insulated working conditions in field situations, use of this method should be limited to only those times where bonded earth mat working conditions are not able to be used.

(b) Remote earths should not be introduced to the local work site earth mat situation where practical. All remote earths connected to the conductors being worked on need to be disconnected. Additional precautions need to be taken to isolate all incoming electric leads (e.g. for lighting and power tools) connected to a remote earth by the use of an isolating transformer, and any oil equipment etc., must be isolated by use of insulating hoses or connectors.

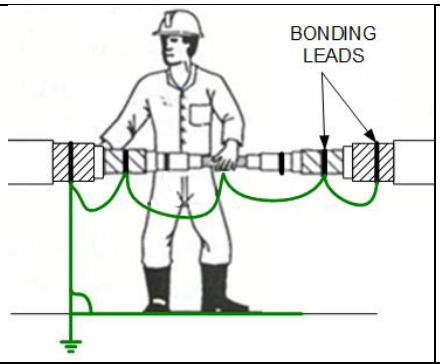
(c) Conductors being worked on should be kept as short as possible by disconnecting phase conductors and/or cable sheath sectionalisation.

(d) The maximum number of continuous and earthed parallel conductors should be maintained at all times to maximise the shielding effect.

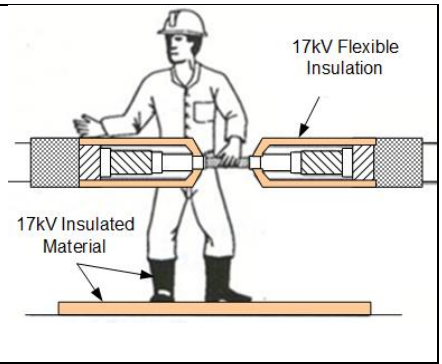
7.2.2.1. Cable repairs



Reinforcing tapes – Insulated Working



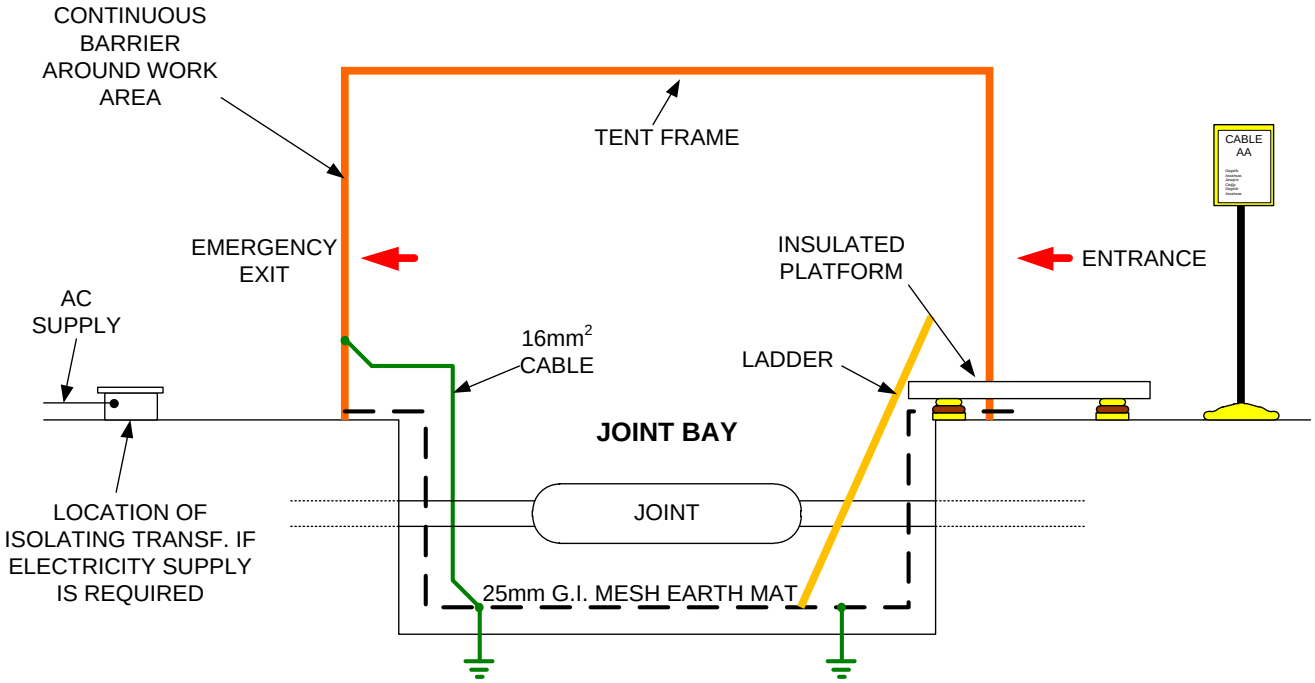
Cable Cores – Bonded Working



Cable Cores – Insulated Working

7.2.2.2. Bonded Earth Conditions

Bonded earth conditions comprise an equipotential area made from conductive material, such as 25mm galvanised wire mesh. The conductive material must be continuously bonded with multiple bonds and must cover the floor, walls and ceilings, as necessitated by the conditions of any areas which can be touched from the working position. An earth stake must be driven to a minimum depth of 600mm at each end of the working area and the two stakes bonded together or, alternatively, a single earth stake may be driven and used in conjunction with the existing earthing system of the cable installation.



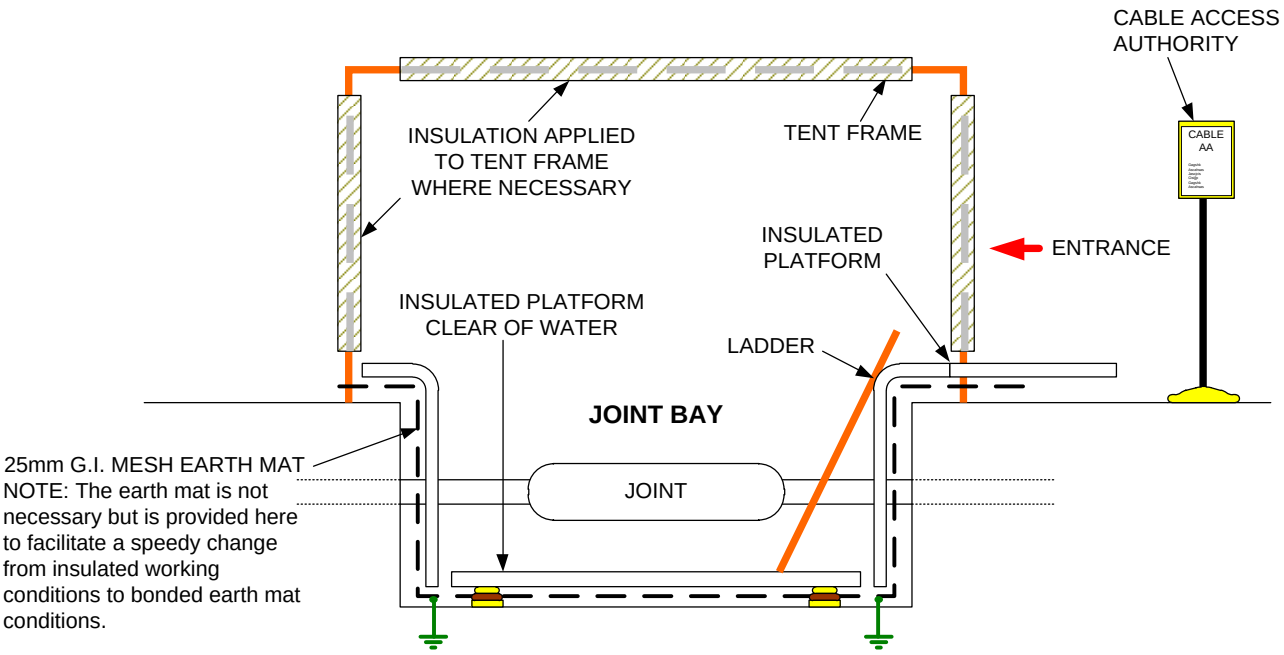
- Side driving of an earth stake is acceptable at locations that are at least 600mm below the surface.
- Regardless of the earthing arrangement used, the overall resistance between the equipotential conductors and the surrounding earth must be less than 10 Ohms.
- All earth connections from the bonded earth mat or from other exposed metalwork must be made effectively and solidly to the earth stake with a conductor of minimum size 16mm2 or equivalent. All exposed and lightly insulated metal objects within the equipotential area must be bonded to the earth stake or covered with a material insulated to withstand 17kV ac.
- A barrier to prevent persons contacting the bonded earth mat must be erected at least one metre from the edges of the working area or associated metallic tent frame. Where this cannot be achieved, this distance may be reduced at the discretion of the authorised person issuing the Cable Access Authority and or the APIC for the Cable Access Authority, subject to other control measures being implemented.
- Access to the bonded earth mat must be made via a non-conductive ladder or staircase and an insulated platform or mat suitable to control step potential effects.

7.2.2.3. Insulated Working Conditions

Insulated working conditions means that an insulated platform must be used within the work zone, and all insulated parts must be kept as clean and dry as possible. All exposed metallic parts of cables and pipes or any other earthed material which can be touched from

Extreme care must be taken when driving earth stakes to ensure no damage is caused to the cable or to other services.

the insulated platform whilst in contact with the unearthed metallic parts of the cable to be worked on, must be covered with a material, insulated to withstand 17kV ac, which must be maintained in as clean and dry a condition as possible. All connections to the earth stake must be made with a conductor of minimum size 16mm^2 or equivalent, insulated to withstand 17kV ac.



- Any person on the insulated platform must not accept materials from or make personal contact with any person not on the platform or touch any earthed object while in contact with the unearthed metallic parts of the cable.
- A barrier to prevent unauthorised entry must be erected at least one metre from the edges of the working area. Where this cannot be achieved, this distance may be reduced at the discretion of the person authorised Receipt of a Cable Access Authority, subject to other control measures being implemented.

Receipt of a Cable Access Authority

7.3. Responsibilities of the Authorised person in charge (APIC)

Persons authorised Receipt of a Cable Access Authority are approved to perform the duties of the authorised person in charge and can receive / suspend / transfer / resume / cancel Cable Access Authorities.

7.3.1. The APIC must ensure:

(a) The location, description of apparatus, description of work and the access required for work as shown on the Cable Access Authority is identical to those on the relevant part on the RFA;

(b) That the apparatus to be worked on is positively identified and is identical to that shown on the Cable Access Authority;

(c) They understand the warnings given by the issuer and their responsibilities under the Cable Access Authority;

(d) All members of the working party have signed onto the Cable Access Authority;

The APIC must rule a line across the signature section, to confirm everyone above the line received warnings and demonstrations by a person authorised Issue Cable Access Authority.

The APIC may permit additional persons to join the work party after the Cable Access Authority has been issued, by giving them relevant warnings and demonstrations before allowing them to sign onto the Cable Access Authority.

(e) Work is restricted to the work area and description of work on the Cable Access Authority;

(f) The Cable Access Authority is kept safe until it is suspended or cancelled and displayed at the entrance when work is carried out in a Designated Work Area;

(g) There is a minimum of one additional person authorised Working under a Cable Access Authority, always signed on the Cable Access Authority;

(h) Additional control measures are identified and applied, so work can be carried out safely under the Cable Access Authority;

(i) That all persons required to work on the Cable Access Authority are:

(i) Either authorised Working under a Cable Access Authority or are given warnings and/or demonstrations appropriate to the work being carried out and adequately supervised to enable them to work as instructed persons;

(ii) Informed as to the apparatus to be worked on, its identification details and the description of work to be carried out and the extent of access to the apparatus;

(iii) Given warnings and/or demonstrations appropriate to the work being carried out;

(iv) Conversant with the warnings/demonstrations given and their responsibilities under the Cable Access Authority; and

(v) Signed off the Cable Access Authority at the completion of their work for each day/shift or when leaving site.

(j) That in the event of the APIC needing to temporarily leave (< 15 minutes) the work area, instructions are given to all persons in the work area to ensure that the relevant provisions of the PSSR are observed during their absence;

(k) That bonding leads are applied to ensure equipotential conditions are maintained during the work or insulated work methods are maintained and used;

(l) That bridging leads are applied, where necessary, to maintain a current path when a conductor is to be broken or disconnected;

(m) The initial and ongoing adequacy of insulating equipment and work methods;

(n) That any equipment that can store capacitive charge is fully discharged using a suitable means of earthing before approaching, or working on or near the apparatus, and before working on the apparatus after electrical testing has been performed.

7.3.2. Testing permitted under a Cable Access Authority

When the proposed test involves a test source which is not capable of producing currents hazardous to the human body and Access Authority earths are unaffected, testing may be carried out without a Cable testing Access Authority, provided the person in charge of the test:

(a) Warns any persons who could make inadvertent contact with the conductors during the course of the test that voltage is to be applied and, in return, obtains an assurance that they will remain clear of the conductors during the test;

(b) Ensures at the conclusion of the work any apparatus under test which may have become electrically charged during the course of the test is fully discharged and left in a safe condition; and

(c) Ensures that the test source is not connected to electrical apparatus with a capacitance greater than 4,000 pF.

7.3.3. Transfer of a Cable Access Authority

Where there is a need to change the authorised person in charge:

(a) The APIC must ensure that the new recipient has received the Access Authority warnings and/or demonstrations from a person authorised Issue Cable Access Authority;

(b) The Cable Access Authority must be signed off by the person currently in receipt of the Cable Access Authority;

(c) The new recipient of the Cable Access Authority must be a person authorised Receipt of a Cable Access Authority and sign onto the Cable Access Authority; and

(d) The Controller must be notified of the new APIC.

7.3.4. Alterations to conditions of work under a Cable Access Authority

Where the description of apparatus and/or the description of work shown on a Cable Access Authority is required to be altered:

(a) The Cable Access Authority requiring the alteration(s) must be cancelled.

7.3.5. Suspension of a Cable Access Authority

Suspension of a Cable Access Authority is required when work is to cease for a period and may remain suspended for a period not exceeding seven days except at the discretion of the Controller.

When a Cable Access Authority is to be suspended, the APIC must ensure that:

(a) All persons working under the Cable Access Authority have signed off, to indicate that permission to work is suspended;

(b) The Controller is notified of the suspension of the work and whether the cable is/is not serviceable; and

(c) The Cable Access Authority, together with attachments, is kept safe.

7.3.6. Resumption of Work Following Suspension of a Cable Access Authority

When resuming work following suspension of a Cable Access Authority:

(a) If the intended APIC is the person who held the Cable Access Authority immediately prior to suspension, then the APIC in charge must:

  (i) Obtain permission from the Controller;

  (ii) Verify that the conditions of the Cable Access Authority covering the apparatus are still valid;

  (iii) Sign on the Cable Access Authority as the APIC;

  (iv) Allow all persons signed onto the Cable Access Authority prior to its suspension to sign back on; and

  (v) Ensure any persons not signed on to the Cable Access Authority prior to its suspension receive appropriate warnings and demonstrations.

Where a Cable Access Authority has been suspended as serviceable and apparatus is required for immediate service, the Cable Access Authority may be cancelled at the direction of the Controller.

(b) If the intended APIC is not the person who previously held the Cable Access Authority, then the intended APIC must comply with ‘Transfer of a Cable Access Authority’.

7.3.7. Cancellation of a Cable Access Authority

Blue Book Clause	Additional Blue Book requirements apply when working in Victoria
9.2.4.1	A Cable Access Authority issued in Victoria must be cancelled by a person authorised Issue Cable Access Authority.

On completion of work, the APIC must:

(a) Prior to cancellation, carry out necessary checks to:

(i) Confirm all bonding/bridging leads and tools are removed;

(ii) Confirm that all persons signed on the Cable Access Authority have signed off;

(b) Cancel the Cable Access Authority by:

(i) Completing the cancellation section of the Cable Access Authority;

(ii) Ensuring that the necessary details are communicated to the Controller;

(iii) Entering the time and date of cancellation of the Cable Access Authority; and

(iv) File the Cable Access Authority, if required for your records.

If it is found that a person has failed to sign off the Access Authority, the equipment must not be returned to service until an assurance is obtained that the person concerned is clear of the apparatus. This must be noted on the Access Authority.

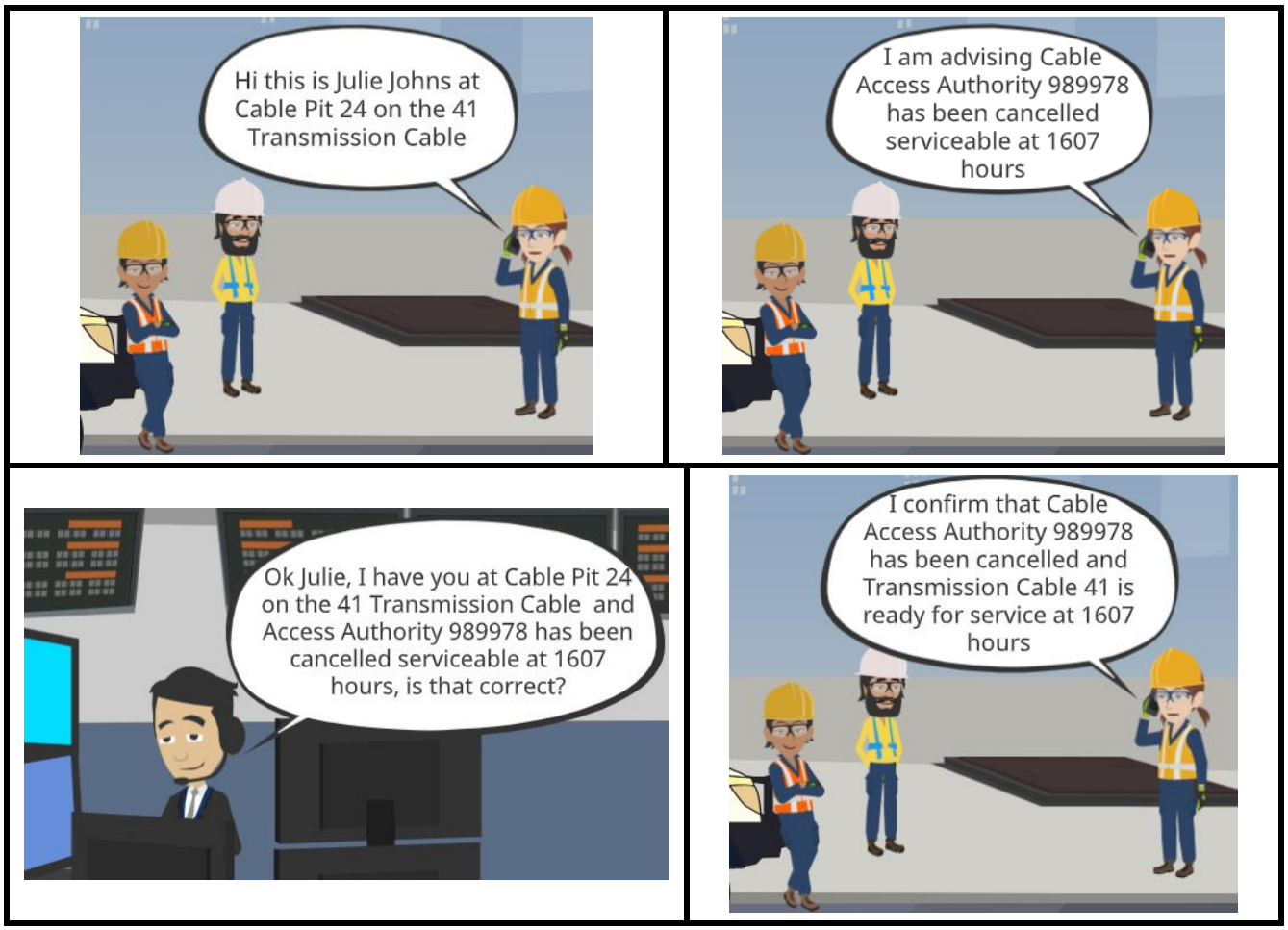
Serviceable

When cancelling an Access Authority, serviceable indicates whether your portion of the work has been completed successfully. Where this is a single portion of a structured series of outages cancelling serviceable does not necessarily mean that the apparatus would be suitable for return to immediate service.

7.3.8. Communicating with the Controller

Network Operations contacts:	
Emergency (02) 96200555	Controller Northern Areas (02) 40145700
	Controller Southern Areas (02) 88180621

Start all messages with your name, location, apparatus and intended purpose of call.



7.3.8.1. Message to Transfer Access Authority

On (apparatus identification) I would like to Transfer Access Authority (number) to new APIC (name) at (time) They have received AA warnings from (issuer's name).

7.3.8.2. Message to Suspend Access Authority

For work on (apparatus identification) I am advising that Access Authority (number) has been suspended and the line is not serviceable as work is not complete.

7.3.8.3. Message to Resume Work

On (apparatus identification) I would like to resume work on Access Authority (number)

7.3.8.4. Message to Cancel Access Authority

For work on (Apparatus identification) I am advising that Access Authority (number) has been cancelled, and the Transmission Cable is serviceable as far as this work is concerned.

Receipt of a Cable Testing Access Authority

A Cable Testing Access Authority must be issued where the work includes:

(a) The removal and/or replacement of Cable Access Authority earths;

(b) The use of a test source which is capable of producing currents hazardous to the human body on the conductors of HV electrical apparatus; and

(c) The application of extra Low Voltages or voltages produced by an insulation testing device operating at 1,000 volts or below, connected to electrical apparatus with a capacitance greater than 4,000 pF.

Persons authorised Receipt of a Cable Testing Access Authority are approved to perform the duties of the authorised person in charge, supervise instructed persons and can receive/ suspend/ resume/ cancel Cable Testing Access Authorities.

7.4.1. Responsibilities of the authorised person in charge of a Cable Testing Access Authority

In addition to the requirements of receiving a Cable Access Authority the authorised person in charge must:

(a) Have knowledge of the work, verify the status of the test devices and control the testing;

(b) Instruct those persons working under the Cable Testing Access Authority regarding work that may proceed safely during the testing and provide any additional warnings that may be applicable;

(c) Direct the control of the switching of the test source energising the conductors covered by the Cable Testing Access Authority;

(d) Ensure adequate communications are maintained with all persons involved in the testing including persons at the remote end of the section or cable under test;

(e) Warn any person:

  (i) In the vicinity of the conductors under test that voltage is to be applied and in return receive an assurance that such person will remain clear of such conductors during the test; and

  (ii) Signed on the Cable Testing Access Authority that they can only work on or near the conductors under test when the authorised person in charge is present to show such persons which conductors are safe to approach.

(f) Where induced or test voltages could be present, ensure that safe working methods are used which restrict persons coming on or near energised conductors and any testing equipment or connection leads;

(g) Ensure that for the duration of electrical testing, the entrance to the cable work area is closed and an approved notice warning that electrical testing is in progress is erected at this closed entrance;

(h) If any exposed conductors to which test voltages are to be applied are out of sight of the person switching the test source, ensure that approved notices are placed to warn against approach to the exposed conductors at such points and either:

  (i) A person is posted to warn others not to approach the exposed conductors during the test; or

  (ii) Fences or equivalent barriers are erected, or shutters closed to prevent any person gaining inadvertent access to the exposed conductors.

(i) Ensure that the HV conductors being tested are safe to be touched or approached whenever this becomes necessary during the progress of the electrical test; and

(j) Ensure that, at the conclusion of the work, any apparatus under test which may have become electrically charged during the test is fully discharged and left in a safe condition.

7.4.2. Special Requirement for Sheath Testing

To achieve an adequate and safe separation between the section of metallic sheath being electrically tested and any other work parties, the person in charge of each work party carrying out electrical testing must ensure:

(a) A conductor is connected to the general mass of earth and is applied to all adjacent sections of sheath during the testing.

(b) Where electrical testing on the metallic sheath of a Transmission Cable involves the opening of any link for the purpose of the test, and the electrical test is in progress, the following must occur:

  (i) A person must be posted to warn others not to approach the open link and sheath; or

  (ii) Fences or equivalent barriers must be erected, or shutters closed to prevent any person gaining inadvertent access to the exposed conductors.

7.4.3. Transfer of a Cable Testing Access Authority

In addition to the requirements of Transferring a Cable Access Authority the new authorised person in charge must:

(a) Verify the status of the test devices and all other equipment associated with the testing; and

(b) Understand the warnings, instructions and applicable demonstrations regarding the devices and equipment that may be operated in conjunction with the test.

Issue Cable Access Authority

Blue Book Clause	Additional Blue Book requirements apply when working in Victoria
9.2.7	A Cable Access Authority issuer must not be the initial recipient of the Access Authority (Self issue is not permitted).

The issue of a Cable Access Authority must be carried out by a person authorised Issue Cable Access Authority.

7.5.1. Responsibilities of the authorised person issuing a Cable Access Authority

The authorised person issuing the Cable Access Authority must ensure that:

(a) They personally transmit to and receive all messages from the Controller concerning the issue of the Cable Access Authority.

(b) They receive advice from the Controller that the cable has been isolated and Access Authority earths applied at all points from which it can be energised;

(c) The unique Access Authority number received from the Controller is recorded on the Cable Access Authority;

(d) A Cable Access Authority must not be issued where the work as requested would affect the safety of personnel working under another Access Authority.

When it is not possible to establish direct communications, such messages may be relayed between the Controller and the person issuing the Cable Access Authority, by another person authorised Issue Cable Access Authority.

(e) The person receiving the Cable Access Authority is authorised Receipt of a Cable Access Authority;

(f) The location, the description of apparatus, the description of work and the nominated access required for work set out on the Cable Access Authority are identical to those stated in the relevant parts on the RFA;

(g) The Cable Access Authority is not issued if it is not safe for the work to proceed;

(h) The cable has been identified using approved procedures;

(i) The cable work area is established using an approved procedure.

(j) The details of the issued Cable Access Authority are communicated to the Controller.

When working within the boundary of a switchyard, a designated work area must be set up around the sealing end and/ or cable work site.

(k) All required applicable warnings are entered on the Cable Access Authority Warning & Hazard Form;

(l) They assemble all persons who are to work under the Cable Access Authority and:

  (i) Demonstrate to them the conductors which are safe to be worked on;

  (ii) Warn them of any other conductors or transmission cables, in the vicinity of the work, which must be regarded as energised; and

  (iii) Warn them to confine their work to that described on the Cable Access Authority and of their 'Responsibilities of persons working under a Cable Access Authority'.

(m) The Cable Access Authority is endorsed as having been issued; and

(n) The details of the issued Cable Access Authority have been communicated to the Controller.

7.5.2. Additional requirements when issuing a Cable Testing Access Authority

In addition to the requirements of issuing a Cable Access Authority the authorised person must ensure that:

(a) The person receiving the Cable Testing Access Authority is a person authorised Receipt of a Cable Testing Access Authority;

(b) A Cable Testing Access Authority is not issued where the test as requested may affect the safety of personnel working under another Access Authority;

(c) Warning Tags are affixed to all control points that are able to operate the apparatus during the test, in accordance with the PRI;

(d) Warnings, instructions and applicable demonstrations are given to the person in charge of the test;

(e) Confirmation has been received from the Controller that all current Access Authorities, for work on or near the conductors required to be electrically tested, are suspended; and

(f) The planned test voltages must not exceed those specified on the RFA.

7.5.3. Sheath Testing Requirements

The issue of a Cable Testing Access Authority for electrical testing of a section of metallic sheath of a Transmission Cable must not prevent the issue of further Access Authorities for:

(a) Work or electrical test on other section(s) of the metallic sheath of the same Transmission Cable; or

(b) Work on the main conductor of other section(s) of the same Transmission Cable;

Provided that the Controller is satisfied that an adequate and safe separation can be achieved between the section of metallic sheath being electrically tested and the other work parties. This requires that:

(c) Between any work party carrying out electrical testing and any other work or electrical test party, there must be a location where the sheath is earthed via an earthed link box or other bonding system. This location must be excluded from any Cable Access Authority.

Identification of Transmission Cables and Pilot Cables

Tests must be carried out to correctly identify a cable prior to any work. Where the location of previously installed cables is discovered to be inaccurately recorded, the records must be updated. Where existing cables are de-commissioned, but left in situ, the records, BYDA and spatial information must be maintained until the cables are removed.

- The location of Transgrid's cables should be identified using Transgrid's cable routing records. The location of other utilities services is available through BYDA.com.au.
- Cable identification involving injection of a signal into the cable sheath must be via induction coupling.

Transmission Cable Identification

The issuer and receiver of the Access Authority carrying out the identification must employ at least two of the following methods, or alternatively, repeat method (a) or (b) from a different location or, using different personnel, from the same location.

(a) Identification from cable route plans, provided route plans are considered a true record.

(b) Local labelling of ancillary equipment directly connected to the cable.

(c) Low voltage audio frequency current injection at the end of the cable into the core and detection of the current at the worksite by an electro-magnetically coupled search coil and amplifier.

(d) Low voltage 50Hz current injection at the end of the cable or bond system from a known/labelled sheath link box. Injection of an interrupted 50Hz current into the core and measurement of the current at the worksite with a tong ammeter or similar device and trigger/interruption pulses identified.

(e) D.C. Simulated Sheath Fault Location Test. Detection of an interrupted sheath earth fault connected at the point of work.

(f) Visual Identification by visually tracing the cable back to its source or bonding leads to link pits which have been correctly identified as in (a) or (b).

(g) GPS coordinates and where true and accurate survey data exists, and no other similar services are in the vicinity.

Pilot Cable Identification

The issuer and receiver of the Access Authority carrying out the identification must employ one or more of the following methods.

(a) Identification from cable route plans, provided route plans are considered a true record.

(b) Visual Identification by visually tracing the cable back to its source.

(c) Identification by Labels from labels at pilot cable marmusting kiosks.

(d) Low voltage audio frequency current injection at the end of the cables. Injection of an audio frequency current into a core or into the insulated metallic screen and detection of the current at the work site by an electromagnetically coupled search coil and amplifier.

(e) Low voltage 50Hz current injection at the end of the cable. Injection of an interrupted 50Hz current into a core or into the insulated metallic screen and measurement of the current at the work site with tong ammeter or similar device.

(f) D.C. simulated screen fault location test. Detection of an interrupted insulated metallic screen earth fault connected at the point of work.

(g) Core continuity. By establishing continuity of an exposed core end at a break in the pilot cable to an identified termination position by injection of a continuous a.c. or d.c. current by megger or similar device, provided such method does not affect system security.

Precautions

Whatever method is used, the authorised person carrying out the identification must affect self-protection, and protection for others from possible dangerous voltages that can occur during a system surge, by the following means:

(a) At cable terminations in high voltage switchyards no connection or disconnection is to be made to any metallic part of a cable unless a local earth is first applied to the metallic part or unless the work is to be carried out under insulated working conditions.

(b) In the field, insulated working conditions must be used to make connections to any metallic part of any Transmission Cable or pilot cable.

(c) Whilst operating the testing equipment, the qualified person must employ insulated working conditions.

(d) Where possible, all metallic parts of a Transmission Cable not being used in the identification procedures must be left continuous and earthed at both ends.

Safe Work Methods

Routine Maintenance

Safe work method statements (SWMS) for conducting cable routine maintenance must reference the following safe working practices.

Sheath Repairs

Insulated working conditions must be established and maintained until at least 3mm radial thickness of insulation has been applied over exposed metallic parts.

Work on Link Boxes

All work on link boxes must be carried out either:

(a) With all links and terminals bonded and earthed in accordance with bonded earth conditions; or

(b) Under insulated working conditions; or

(c) Where it is necessary to remove links for identification or testing purposes, an approved type of insulated working must be used.

Work on Oil System Equipment

(a) Where work is required between the insulating section in the metallic pipes and associated joint or sealing end the work must be treated as a metallic part repair.

(b) Any temporary feed pipe must be insulated from the metallic parts.

(c) Any work on cable oil systems requiring the cable out of service for safety of equipment must not be commenced until clearance has been received from the Controller.

Work on Cable Pressure Monitoring Equipment

(a) Cable “low oil” alarm equipment in the field is usually shrouded to prevent accidental contact with metallic parts that can be livened up due to induction or transferred earth potential.

(b) When it is necessary to work on such metallic parts (for example on the contact assembly of a pressure gauge) insulated working conditions should be established.

(c) Bonded earth conditions may be used provided the user ensures that the earthing of pilot cores is not harmful to the alarm system.

(d) Caution is also required to ensure that personal contact is not made with more than one core at a time except for where cores are commoned.

Use of Instruments and Testing Equipment

Instruments and testing equipment must conform to the requirements specified in Appendix C.

Non-Routine Maintenance

Safe work method statements (SWMS) for conducting cable non-routine maintenance must reference the following safe working practices and consider any cable type and manufacturer specific requirements for the equipment to be worked on.

Cutting a Cable

The following steps are to be followed if a Cable needs to be cut.

(a) Identify the cable.

(b) Set up an exclusion zone around the cable to be cut.

(c) If necessary, use a remote detonation earth spike.

(d) Setup a remote operated cutter/guillotine and bond cutting head with a 16mm^2 cable to local earth/stake.

(e) Bond all metallic parts of each end locally with 16mm^2 cable. If this is not practical, bridge all metallic parts across the cut with 16mm^2 cable. Alternatively (or in conjunction) apply 17kV insulated capping.

(f) Contain any oil loss.

Making a Joint in a Transmission Cable

Cable jointing is a highly specialised activity and the safe work methods and controls will vary depending on the cable type and manufacturer. Type and manufacturer specific techniques, hazards and controls must be considered when the safe work method for the work is being developed.

An example of jointing techniques and safety controls is provided in Appendix G.

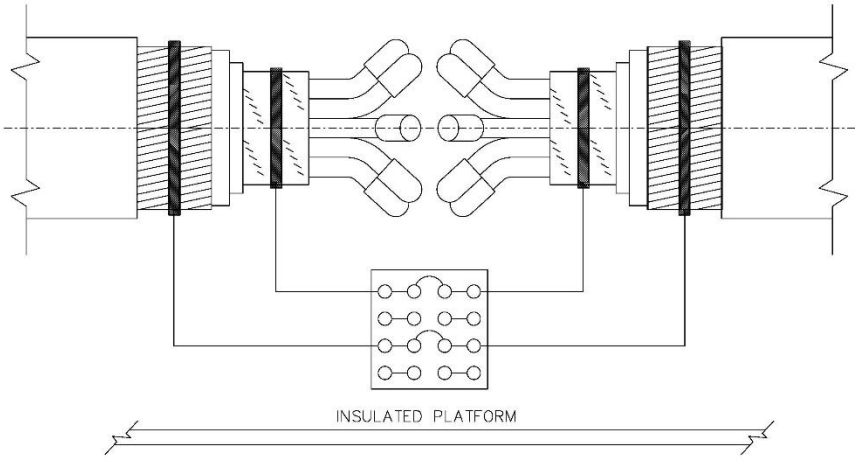
Making a Joint in a Pilot Cable

Initial Preparation

(a) Prepare the cable ends as outlined in Section 6.1.2 (a) to (g). Great care must be taken to ensure that bonding is completed, as shown in the following figure, by connection to the earthing board i.e., not by direct connections.

(b) Continue with insulated working conditions.

(c) Select the first pair to be joined and remove the temporary insulation. Slip on a core insulating sleeve and/or an insulated sleeve of material which will withstand 17kV ac.



PILOT CABLE WITH METALLIC PARTS BONDED TO EARTH

(d) Handling one core end by the insulated sleeve and the other core end with its own insulation, lay down the core ends and mark the core joint positions.

Ferruled Core Joints

(a) Cut and strip the core end and crimp a ferrule on the core end, avoiding contact with the other core end.

(b) Handling one core end with insulated sleeve and the other core end with its own insulation, bring the two core ends together in the ferrule and complete crimping or sweating of the ferrule.

(c) Bring the core insulation sleeve over the core joint before proceeding with the next core joint.

Twisted Core Joints

(a) Bare the sections of cores only where the twist is to be made and complete at least one metal-to-metal turn without bridging the conductors by hand. The bare conductors are then safe to handle to complete the joint.

(b) Bring the core insulation sleeve over the core joint before proceeding with the next core joint.

Completion of Joints

(a) Remove the temporary insulating material from the innermost metallic part.

(b) Complete the continuity of this metallic part.

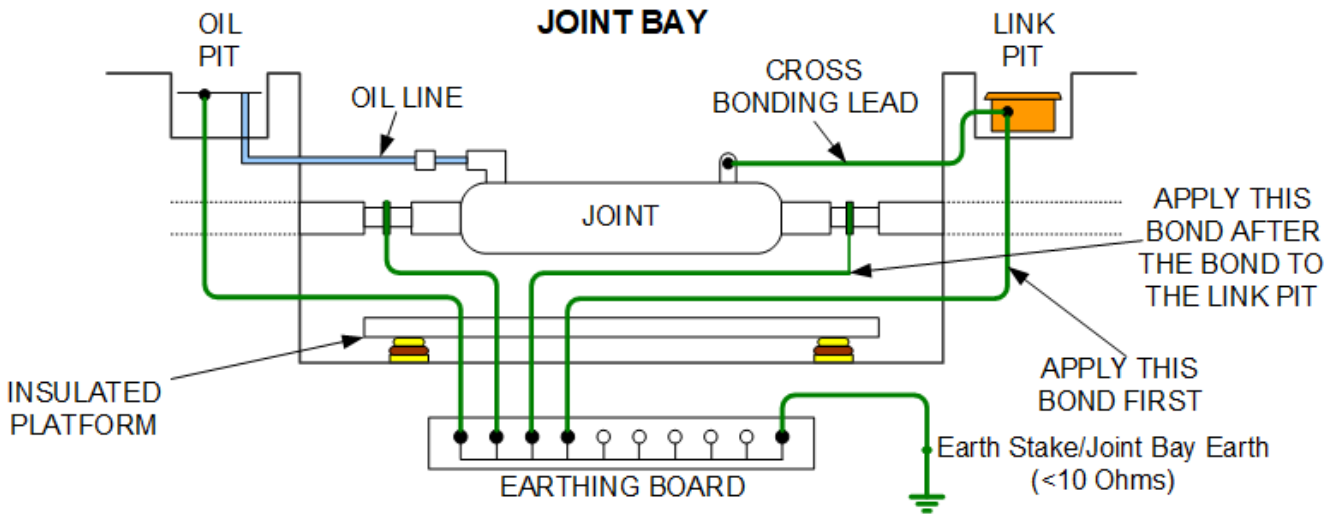
(c) Remove the bond on the innermost metallic part and apply insulation.

(d) Repeat steps (a) to (c) above for other metallic parts.

Breaking Down a Joint in a Transmission Cable

(a) Utilising insulated working conditions expose a section of the outermost metallic part on either side of the joint.

(b) Using bonding leads and an earthing board make a connection between the exposed metallic parts and an earth stake.



(a) If oil lines and/or bonding leads are connected to the joint in question, then these lines and/or leads must also be connected to the earth stake. If these connections cannot easily be made near the joint, then they may be made in the adjacent oil, gas or link pits.

(b) Establish bonded earth conditions.

(c) Expose the joint sleeve (this usually involves de-compounding).

(d) Disconnect oil pipes and bonding leads if required.

(e) Remove joint sleeve.

(f) Remove screen and stress wire if required.

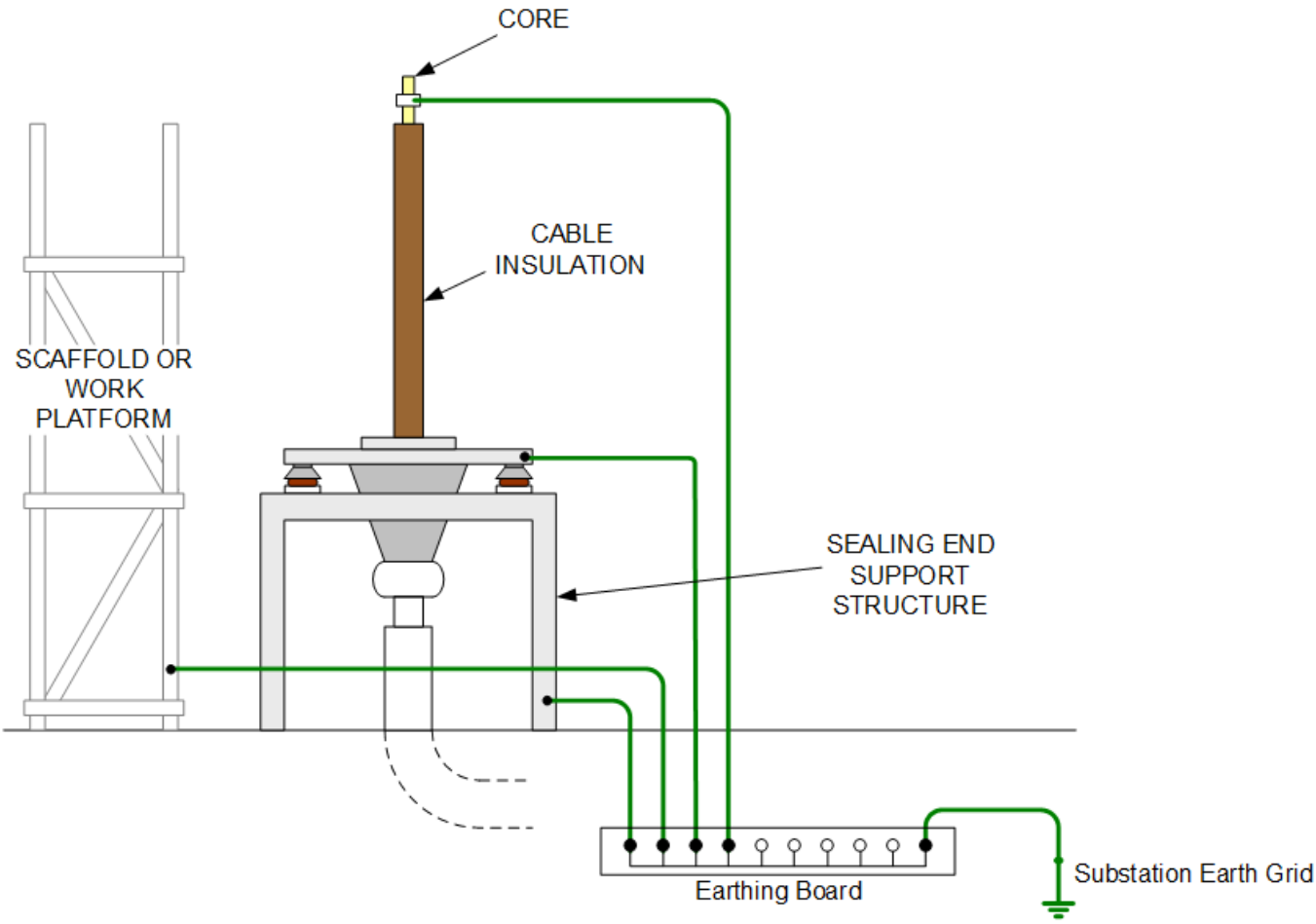
(g) Re-establish insulated working conditions.

(h) Remove insulation.

Note: Details may vary depending on the cable type and manufacturer.

Constructing a Sealing End on a Transmission Cable

(a) The sealing end supporting structure and working platform scaffolding must be effectively earthed to the local earth mat or earth stake as shown below.

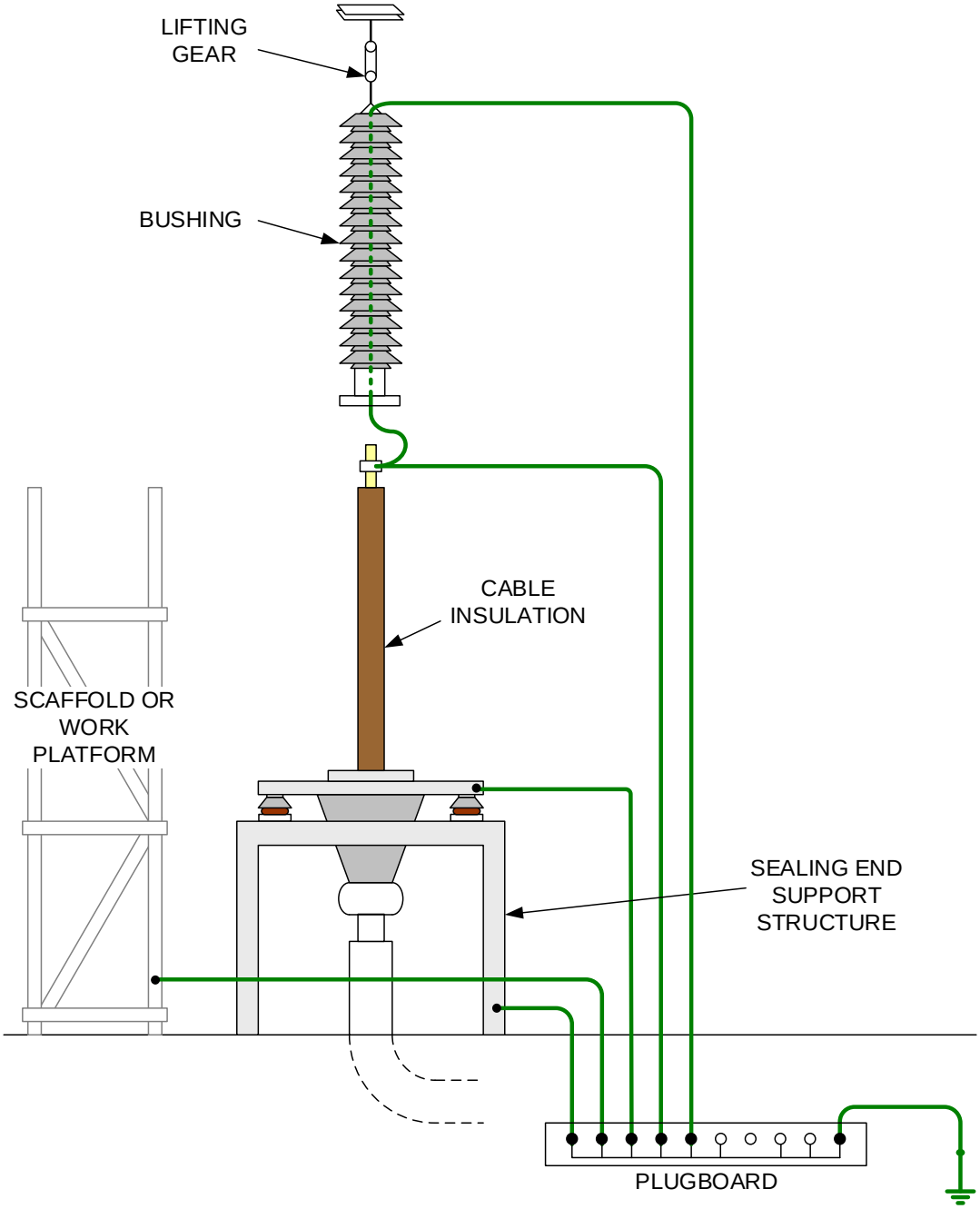


(b) Prepare the cable

(c) Continue with bonded earth conditions.

(d) The earth bonds to all metallic parts must be maintained throughout all trimming, taping and screening operations until the bushing is in position ready to be lowered over the cable head.

(e) Before removing the original core earths a bonding lead connection must be made to the core passing up through the bushing as shown in the following figure.



(i) The bonding lead is to be maintained until electrical contact is made with the top bushing fitting and this fitting is solidly earthed.

(ii) The core earth must not be disconnected until standard earthing equipment has been applied.

(f) If it is not possible to comply with step (e) due to the design of the sealing end, the sealing end earth may be removed and the bushing lowered into position using insulated working conditions. The earth must be replaced as soon as possible and the remainder of the work carried out under bonded earth mat conditions.

Breaking down a Sealing End in a Transmission Cable

(a) If the sealing end has not already been earthed, make a connection between the primary conductor of the sealing end and the earth. Insulated working conditions must be used during this operation.

(b) Continue with insulated working conditions and ensure that there is a connection between the metallic cable sheath and earth.

(c) If oil lines and/or bonding leads are connected to the sealing end, then these lines and/or leads must also be connected to earth.

(d) The sealing end supporting structure and working platform scaffolding must be effectively bonded to the earth mat.

(e) Establish bonded earth mat conditions.

(f) Without removing the earth connection on top of the sealing end, expose the conductor within the top of the sealing end and connect a bonding lead between the conductor and the earth. The bonding lead must be long enough to pass through the bushing as it is being withdrawn.

(g) Remove the external oil pipes.

(h) Without disturbing the bonding lead remove the main earth connection from the top of the sealing end and remove the bushing.

(i) If it is not possible to comply with step (f) due to the design of the sealing end, the sealing end earth and the bushing may be removed using insulated working conditions. The earth must be replaced as soon as possible, and the remainder of the work carried out under bonded earth conditions.

Terminating a Pilot Cable

Terminating in Pilot Isolation Kiosks

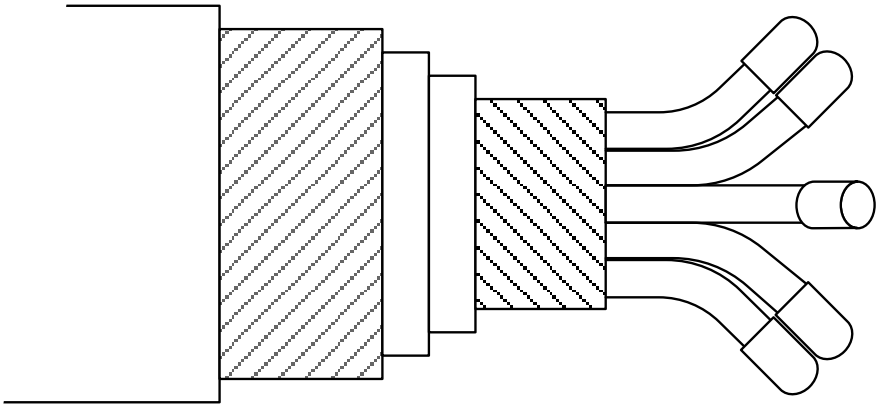
(a) Check that the insulating rubber floor matting is present and in good condition. Temporary additional matting may be required in order to establish insulated working conditions.

(b) At all remote terminating points, all conductors must be isolated from their terminal equipment and all other metallic parts must be isolated from earth wherever possible.

(c) A section of the outermost metallic part must be exposed and then be shrouded with temporary insulating material which will withstand 17kV ac.

(d) Any other metallic part must, in turn, be exposed and treated in the same manner until the insulated cores are exposed.

(e) The exposed core ends must be insulated from each other as shown below. Where this is not possible an alternative technique can be used provided it ensures the safety of the work party.



Pilot Cable – Cores Insulated from each other

(f) Ensure that the plugs on the terminal strips are removed. Treating one core at a time, remove the core insulation and join the core to its terminal strip. Permanently insulate each termination before proceeding to the next.

(g) On completion of all terminations remove the temporary insulation over the innermost metallic part.

Note: Some metallic parts such as armouring or metallic sheaths are permanently earthed, whereas other metallic parts (such as metallic screens) are deliberately not earthed. Steps (h) to (j) indicate how these permanent earths should be applied.

(h) Using bonding leads, bond the exposed metallic part to the earth busbar provided in the isolation kiosk. Great care must be taken to ensure that this bonding is carried out by connecting to the earthing board, i.e. not by direct connection.

(i) The innermost metallic part may now be permanently earthed to the earth busbar.

(j) The bonding leads applied in (h) may now be removed.

(k) If permanent earthing of the innermost conductor is not required, then full insulation must be applied over it.

(l) Repeat steps (g) to (k), as appropriate, for all other metallic parts in turn.

Terminating at Locations other than in Isolation Kiosk (including Cable Road Pits)

(a) Establish insulated working conditions.

(b) At all remote terminating points, all conductors must be isolated from their terminal equipment and all other metallic parts must be isolated from earth wherever possible.

(c) Prepare the cable.

(d) Establish bonded earth mat conditions.

(e) Earth all terminal strips to which connections are to be made and where removable links are provided, ensure that the links are removed.

(f) Handling the core by its permanent insulation, remove the temporary insulation and terminate the core on its terminal strip.

(g) Terminate all other cores in turn as outlined in (f).

(h) Complete the termination of the cable as detailed in Section 0 (g) to (l).

> **Caution**
>
> Whereas the terminals in an isolation kiosk are fully shrouded, the terminals at other locations are usually fully exposed. Care must be taken that once a core is terminated, no further personal contact be made with it and another core. A form of temporary shrouding may be necessary.

Metallic Part Repairs of Transmission Cables or Pilot Cables

All work must be carried out utilising either bonded earth conditions or insulated working conditions.

The bonded earth conditions method of working must be the preferred method. The insulated working conditions method would normally only be used for metallic part repairs where the extent of the repairs and the time taken to effect the repairs is small.

Metallic Part Repairs Utilising Insulated Working Conditions

(a) Establish insulated working conditions.

(b) Expose the outermost metallic part.

(c) If continuity of the outermost metallic part is already broken because of damage or if continuity has to be broken to effect repairs, a “through bond” must be established using bonding leads and a earthing board in a similar way to that shown for cutting a pilot cable.

(d) If the repairs require that more than one metallic part be exposed then the metallic parts must be insulated from each other using material which will withstand 17kV ac.

(e) Repair the innermost faulty metallic part and apply permanent insulation over it.

(f) If more than one metallic part was exposed, remove the temporary insulation applied in step (d), effect repairs on the next outermost metallic part and so on.

Metallic Part Repairs Utilising Bonded Earth Mat Conditions

(a) Prepare the work but in this case use an earthing board with the earth not connected.

(b) Establish bonded earth mat conditions by connecting an earth to the earthing board and repair the innermost metallic part.

(c) Change to insulated working conditions by removing the earth connection to the earthing board.

(d) Using insulated working conditions the bond wire(s) may be removed from the innermost metallic part and full insulation applied.

(e) If repairs to more than one metallic part are involved, then the remaining metallic parts may be repaired by again reverting to bonded earth mat conditions or by continuing with insulated working conditions.

Appendices

Appendix A – Insulating Materials and Equipment

Insulated Platforms, Sheets or Mats

Insulating sheets must be either Neoprene or EPMD rubber to Class 2 (17kV) from IEC 61111

SWMS involving use of these items should consider:

- Cleanliness requirements;
- Installation location for step potential;
- Installation/Environment requirements;
- Checks for potential damage due to wear and tear and heat;
- Potential for reduced effectiveness due to movement;
- Risk of moisture contamination;
- Prior use inspection for cuts and tears; and
- Testing requirements (6 monthly)

Insulated Gloves and Footwear

Insulated gloves and Footwear must be:

- Manufactured, tested and stored in accordance with recognised standards.
- They must be appropriately rated, both mechanically and electrically for the task to be performed.
- They must be inspected immediately prior to use to ensure they are in suitable condition to perform the work.

IEC 60903 is currently used as the standard for insulating gloves

Appendix B – Earthing & Bonding Clamps and Leads

For the attachment of an earth lead or bond lead to a sheath, core, etc., a bonding cable must be used which has clamps which:

- Are of adequate mechanical strength to support the attached earth lead or bonding lead; and
- Can be tightened to produce a stable and effective contact between the clamp and the core or sheath surface.
- The earthing leads or bonding leads must be made of a conductor of minimum size 16mm^2 copper equivalent.

Appendix C – Isolating Transformers, Instrument Transformers and Testing Equipment

Isolating Transformers

To ensure that remote earth potentials are not transferred to the worksite, all electrically operated portable tools, lead lamps, etc., must be supplied from an isolating transformer which electrically separates the incoming power supply and its earth system from the power supply to the worksite. The isolating transformer must:

Provide an insulating barrier between its input and output windings and between output windings and case and core which will withstand 17kV ac.

Have its core and case earthed to the “supply side” earth.

The secondary winding of the isolating transformer must supply only the load that is within the confines of the bonded earth mat working area. Secondary terminals, and cabling (up to at least the edge of the bonded earth mat) must be insulated to withstand 17kV ac or delineated to ensure it cannot be touched.

Note: any electrical plant or equipment used on the bonded earth mat which requires earthing must have its earth lead connected to the local earth stake. In all other cases earth leads of electrical plant and/or equipment must be earthed in accordance with the SAA Wiring Rules. Where possible, RCD/earth leakage protection devices must be used.

Instrument Transformers and Testing Equipment

All instrument and testing equipment must conform to and be used in accordance with one of the following conditions:

All internal circuit components must be completely covered by a rigid case from which they are insulated. The insulation between the circuit components and the case must be capable of withstanding 17kV ac.

All terminals for connection of external test leads and control adjustments, range switches and the like, must be covered by an insulation which will withstand 17kV ac.

Such equipment may be operated under bonded earth mat conditions or insulated working conditions.

Under bonded earth mat conditions no connection or disconnection of this equipment must be made to the cores or sheaths unless these cores or sheaths are earthed.

For mains power test equipment, all internal circuits must be enclosed in a metallic case which is fitted with an earth terminal. The earth connection between the earth terminal and the earth stake must be a stranded conductor not less than $4mm^2$ or equivalent.

All terminals for connection of external test leads and the external sections of control adjustments, range switches, movement adjusting screws and the like must be covered by insulation which will withstand 17kV ac.

Such equipment may be operated under bonded earth mat conditions provided that:

If it has a metallic case, of the instrument is bonded to the local earth stake prior to making any connections from the instrument to any cable sheath or core.

The connection bonding the metallic case to the local earth stake is not removed whilst the instrument is connected to a cable sheath or core.

If no special case or high voltage insulation is provided, the equipment must only be used whilst working under insulated working conditions.

The operator of the equipment must ensure that personal contact is made with only one conducting part of the instrument at any time. This will enable operation of instrument controls, such as range switches, but will not permit making or breaking of connections.

High voltage insulating links or jacks must be used in test leads. Such links or jacks must be capable of withstanding 17kV ac both across the opened link and from conductive parts (including operating handle or plug) to earth.

Earthing of a high voltage cable section or sheath must be via a discharge resistor and must be applied under insulated working conditions, usually incorporated into the handle and insulated to 17kV.

Appendix D – Earth Stake and Cable Spike

Earth Stake

The standard earth stake must at a minimum be a copper clad steel earthing rod (1.4m x 13mm) with a clamp arrangement suitable for 16mm^2 conductor.

Cable Spike

Transgrid does not have standard cable spiking equipment. Appropriate equipment is to be risk assessed, have work methods prepared and approved for use if required.

Appendix E – Earthing board

The standard earthing board used in Transgrid is a 6mm fixed earth strap with brazed studs with wing nuts (size 12mm). It has a clamp plate for attachment to steelwork and mesh earth mat.

Appendix F – Induced Voltages

A person installing or working on the metallic parts of a HV cable (cores, sheath, armour wires, bonding leads, oil lines, etc.) may be subject to dangerous voltages and electric shock if appropriate working procedures are not followed.

Dangerous voltages due to induced and\or transferred voltage rises may occur even though the cable is isolated from the electrical system and solidly connected to earth.

It is important to understand that whilst it may be perfectly safe to work on an out of service HV cable under normal system conditions, dangerous voltages can occur expectantly at any time as a result of:

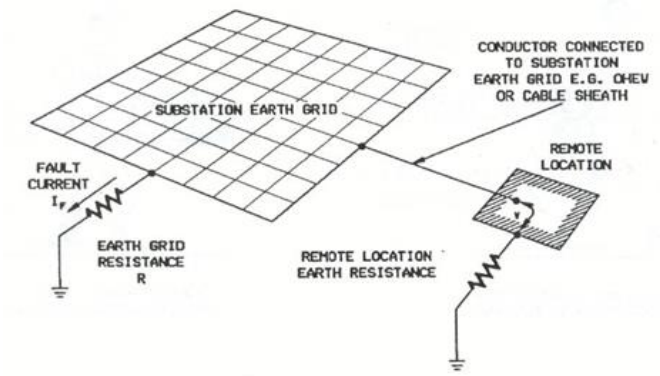
- Faults on the main electrical system
- System switching or other voltage surges
- Lightning strikes, etc.

It is important to carefully consider the voltages that may appear on an HV cable and determine the correct safe working methods to be employed before any work is undertaken.

Transferred Voltage Rise Conditions

Under system earth fault or system switching conditions, large currents can flow via the earthing system to the supply transformer. As the earthing system has a definite resistance to true (or remote) earth, the passage of current through this resistance will cause the earthing system and all conductors connected to it, to rise in voltage relative to true earth. Where the conductors connected to the earthing system are insulated too, rise will be transferred along the insulated conductor.

The figure below illustrates the path formed when a conductor is connected between a remote earth and a substation earth mat.



TRANSFERRED EARTH GRID POTENTIAL

Also the sharing of earth return fault current by the metallic sheath or armour wires, where applicable, of a HV cable will result in a voltage rise on the sheath or armour wires relative to true earth.

Transferred voltage rises can also occur on insulated conductors as a result of direct contact between overhead power circuits or lightning strikes.

If a cable is connected to a section of overhead line it is advisable not to work on insulated conductors if lightning activity is anticipated or present.

Induced Voltage Conditions

Current flowing in fully insulated power cable systems, overhead or underground, may give rise to induced voltages in nearby parallel fully insulated power or supervisory cables. There are two main types of induced voltages:

- Electrostatic (Capacitive), and
- Electromagnetic

Electrostatic (Capacitive) Induction

Where a conductor is located within the electric field of an energised conductor, an electrostatic voltage will be induced in the conductor.

The voltage due to electrostatic induction is constant along the conductor and the application of an earth to an otherwise insulated conductor will effectively drain the charge from the conductor and reduce it to earth potential. The application of multiple earths will not result in circulating currents.

Electromagnetic Induction

Where a conductor is located within the varying magnetic field of an energised conductor carrying alternating current, an electromagnetic voltage will be induced in the conductor. These electromagnetically induced voltages are commonly referred to as low frequency induction.

The voltage due to electromagnetic induction appears as a difference in potential between the ends of the conductor and the application of an earth to one end of an otherwise insulated conductor will result in a potential above earth at the remote end. The application of a further earth at the remote end will result in a circulating current in the conductor.

If a conductor subject to electromagnetic induction and earthed at both ends is cut, a voltage will appear across the cut ends of the conductor. This can be avoided by placing a bonding conductor across the proposed cut position prior to cutting the cable.

Under power system fault conditions heavy fault current will flow for the period taken for the protection equipment to open the faulty circuit. These heavy currents can give rise to very high electromagnetic induced voltages in adjacent parallel conductors (and metallic cable sheaths and armouring).

Unacceptably high electromagnetically induced voltages can occur from adjacent circuits carrying normal load current. The magnitude of the induced voltage is dependent upon separation of the circuits, lengths for which the circuits are parallel and magnitude of the local current.

Shielding Effects

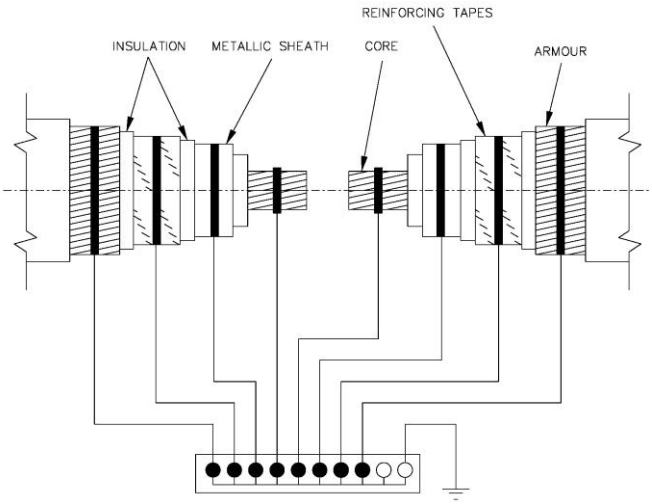
Electromagnetically induced voltages can be reduced if there is another conductor in the vicinity that is connected to earth in at least two locations that would allow an opposing current can circulate. The amount of shielding provided depends on the number and spacing of these conductors.

The conductors of a metal sheathed cable with porous textile servings are effectively shielded as the cable is continuously earthed through saturated/non-insulating servings. However, metallic sheathed cables with a plastic serving are not effectively shielded unless the metal sheath is earthed at both ends.

Appendix G – Making a Joint in a HV Cable - Example

The following steps provide an example of how a joint may be performed. Techniques and necessary safety controls will vary depending on the manufacturer and cable type and those specific considerations must be considered when the safe work method for the work is being developed.

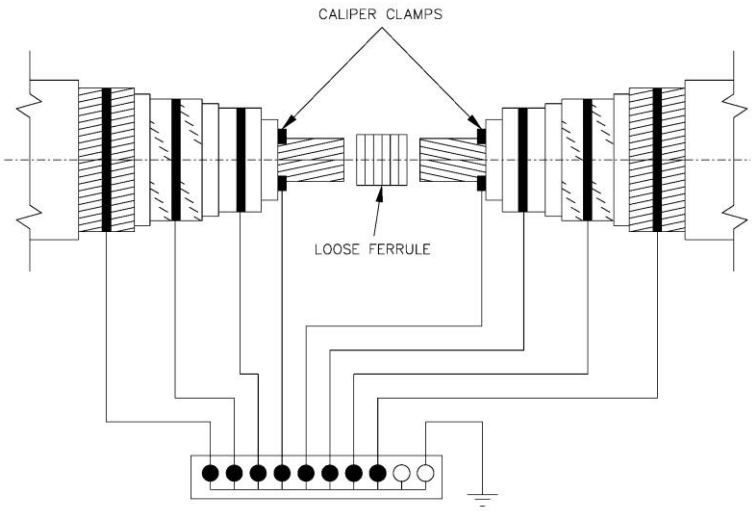
(a) Prepare each cable end in turn, the ends being bonded as shown in the following figure.



HV CABLE WITH METALLIC PARTS AND CORE BONDED TO EARTH

(b) Continue with bonded earth mat conditions.

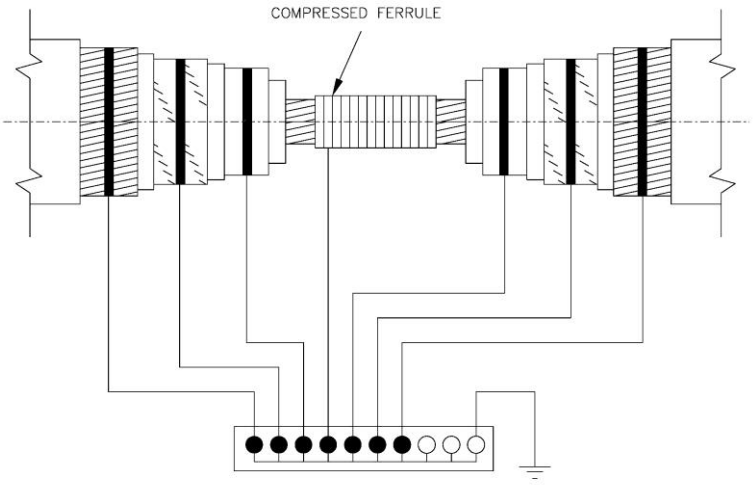
(c) Apply a conductor calliper clamp to the core as close as possible to the insulation on either side of the loose ferrule. The conductor earth clamps applied previously can now be removed as shown in below.



HV CABLE WITH CALIPER CLAMPS APPLIED TO CORE

(d) Join the cores of the cable ends together by compressing the ferrule.

(e) Using bonding leads apply an earth to the ferrule via the earthing board. The calliper clamps applied in step (c) can now be removed as shown in below.



HV CABLE WITH COMPRESSED FERRULE APPLIED TO CORE

(f) Establish insulated working conditions at the worksite.

(g) Temporary insulating material, which will withstand 17kV ac, must be applied over the exposed metallic parts but not over the core.

(h) Break continuity of the earth connection to the ferrule by removing the appropriate connection on the earthing board. The earth clamp on the ferrule may now be removed.

(i) Apply insulation to the core until at least 3mm radial thickness of insulation has been applied to the joint.

(j) Re-establish bonded earth mat conditions. The temporary insulation applied in step (g) may now be removed.

(k) Proceed as follows:

(l) For uninsulated and poorly insulated metallic sheath systems continue jointing under bonded earth mat conditions until contact with metallic parts is no longer necessary. This will usually last until the final attachment of the permanent earth connection or to the start of the bitumen filling of the coffin.

(m) For fully insulated and/or cross-bonded systems where joints have no cross-bonding or earth connection facilities continue under bonded earth mat conditions until the temporary earth connection must be removed to complete joint insulation. At this stage insulated working conditions must be set up and employed until sheath insulation is completed.

(n) For fully insulated and/or cross-bonded systems where joints have cross-bonding or earth connection facilities, permanent bond leads are attached to the sleeve. The temporary sheath earth can then be removed and the sheath insulation completed after the permanent bond leads are earthed. Where the permanent bond leads are connection to an earth stake rather than the permanent link box, insulated working conditions must be set up to remove the bond leads from the earth stake. The exposed ends of the bond leads must be insulated to 17kV. Subsequent work on these leads must be carried out under insulated working conditions. Alternatively, the bond leads may be spiked and work carried out under bonded earth mat conditions.

Safe Approach Distances to Exposed Conductors

Safe Approach Distances apply to PSSR authorised persons working on assets owned or operated by Transgrid. Work in the vicinity of another organisation's assets must be in accordance with relevant Codes of Practice unless arrangements which have been made between Transgrid and the other organisation.

SAFE APPROACH DISTANCES

Nominal Voltage (V):	ELV <50V AC or <120V DC	LV >ELV and <1000V AC or <1500V DC	Distance (m)
Persons	No contact	0.25 (250mm)	
Persons +	Insulated contact	Insulated contact	

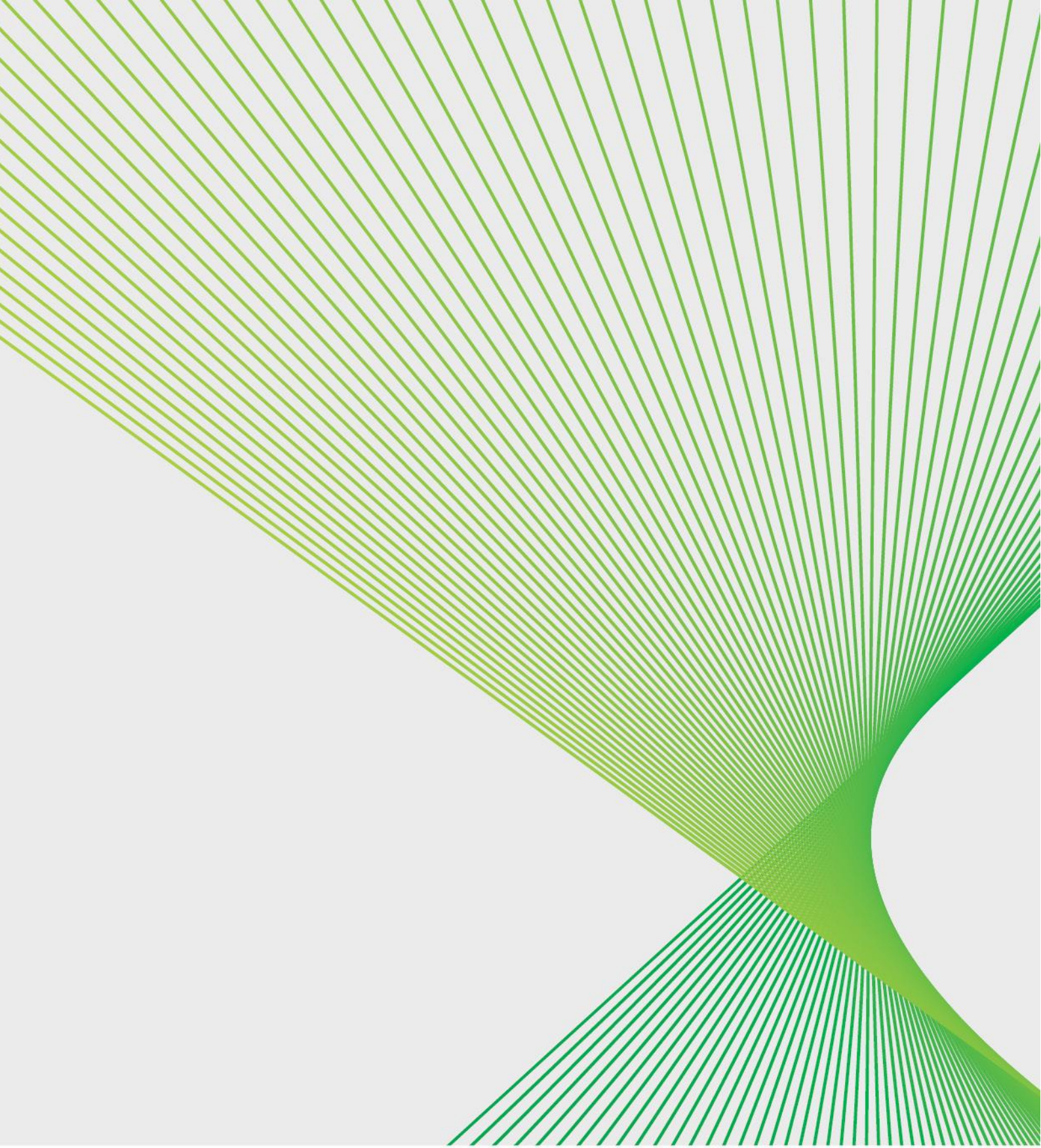
Persons + = Persons authorised 4.1, 4.3 or 9.1

Nominal Voltage (kV):	11-33	66	132	220	275	330	500	Distance (m)
Persons	0.7	1.0	1.2	1.8	2.3	3.0	3.9	
Vehicles *	0.7	1.0	1.2	1.8	2.3	3.0	3.9	
Mobile Plant	3.0	3.0	3.0	6.0	6.0	6.0	8.0	
Mobile Plant +	1.2	1.4	1.8	2.4	3.0	3.7	4.6	

Vehicles * = Includes mobile plant stowed for transit

Mobile Plant + = Mobile plant operating with restrictive devices applied or an authorised safety observer appointed

- Safe Approach Distances for persons means the minimum distance from exposed conductors that must be maintained by a person and/or their equipment.
- Safe Approach Distances for vehicles means the minimum distance from exposed conductors that must be maintained based on the transit envelope of the vehicle, including its load and attachments.
- Safe Approach Distances for mobile plant means the minimum distance from exposed conductors that must be maintained between the mobile plant including its load, controlling ropes and any other accessories.



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