Engineering Instruction Electrical Distribution Unit	EI D 19-07
Approved by: Nadine Youssef, Associate Director, Electrical Distribution Unit, Sydney Trains **Authorised by:** Jonathon Mckinnon, Engineering Technical Publications Manager, Sydney Trains	Date in Force: 5 October 2019 Date Expires: 5 October 2020
This Engineering Instruction includes urgent engineering information. Adherence to the information in this Instruction is **MANDATORY**.	

Fameca Tag2020 High Voltage Testers

Audience:	Main Points:
• Electrical Authorised Operators	• Tag2020 tester is NOT APPROVED • No further purchases are permitted • Existing Fameca Tag2020 HV testers may only be used in very restricted circumstances

Primary Affected Document: PR D 78203 High Voltage Operating Procedure

Scope

This engineering instruction prohibits the further purchase of non-approved testers and live line tools, including the Fameca Tag2020 testers.

Taplin testers must be used whenever they are available in preference to the Tag2020 testers. Existing Tag2020 testers may only be used in the very limited circumstances set out in this EI.

Background

PR D 78203 High Voltage Operating Procedure directs the Authorised officer to the use of approved High Voltage testers.

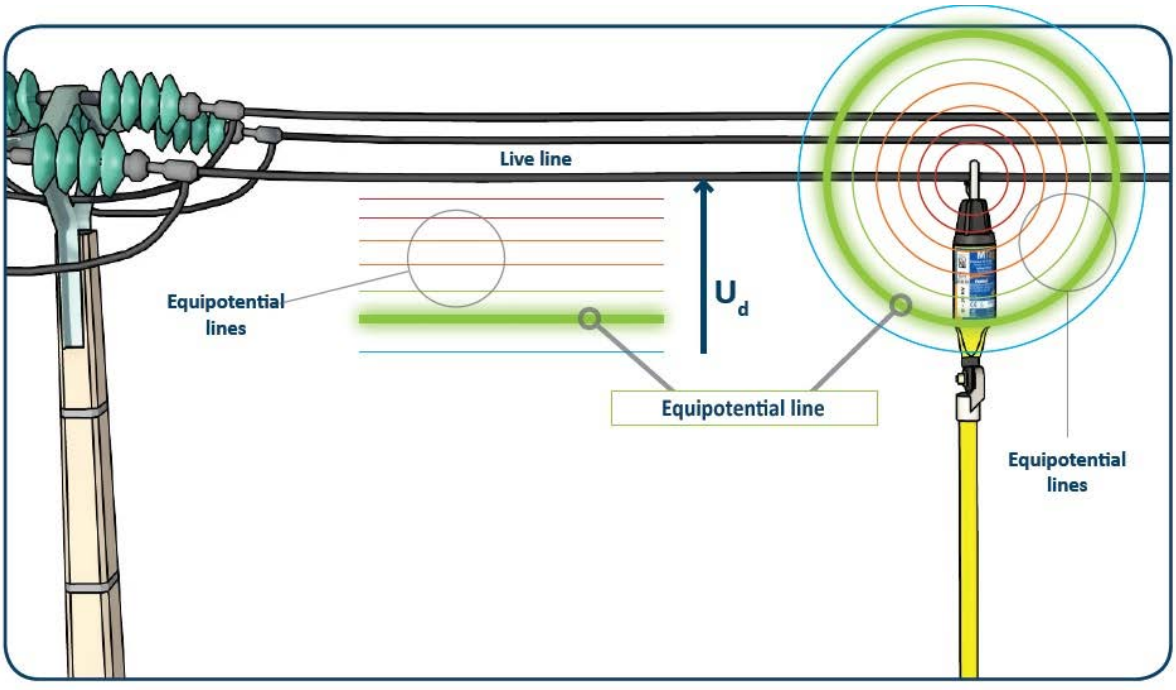
An example of the Taplin HVAC Voltage Tester is shown below, with the hook/probe attachment:

Engineering Instruction

The Taplin testers are no longer available and Fameca Tag2020 testers have been purchased to supplement the existing testers as a trial. The Tag2020 is a contact capacitive voltage divider, which measures the electric field (i.e. voltage) gradient between the top and bottom of the tester.

Users must be aware that the readings from this tester will vary depending on the orientation of the tester, as well as the shape of the object and the presence of other nearby conductive surfaces that affect the voltage gradient, such as other nearby conductors and metallic masses (e.g. metal structures, cable trays, hardware, supports, transformers, bridges, droppers, connectors, cable terminations, down leads, etc.).

It is designed to give a correct reading when the tester is perpendicular to the equipotential lines of the electrical field around a conductor, as shown below:



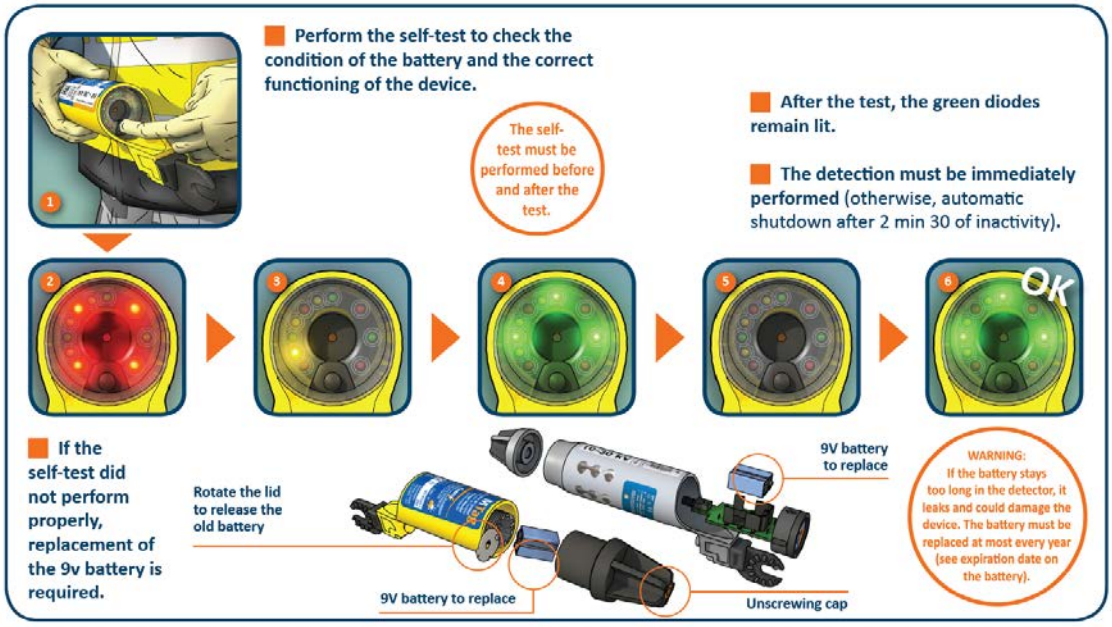
At other angles, it will give incorrect (low) readings and in particular, it may give a false de-energised indication if the tester is parallel to the electric field equipotential lines.

Action required

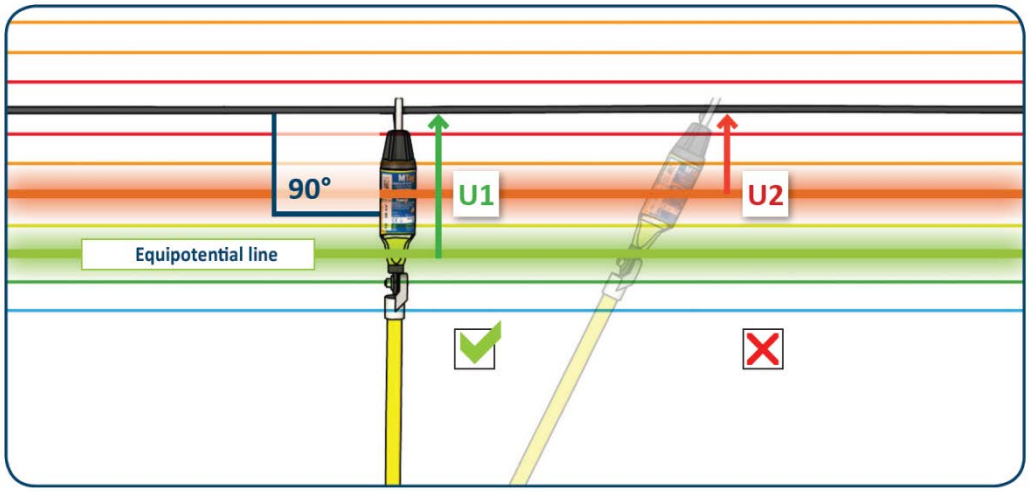
1. Non-approved testers, including the Tag 2020 tester, shall not be purchased from this point on.
2. Taplin testers are to be used in the first instance where possible for proving equipment as dead
3. A new tester is being investigated and will be approved for implementation as soon as possible.
4. The Tag2020 tester is under a trial and may only be used in circumstances where an approved tester (e.g. a Taplin tester) is not available, with the constraints as follows:

WARNING!
If the Tag2020 tester is incorrectly used (as described below), it may indicate that the feeder is "DEAD" when it is actually "LIVE".

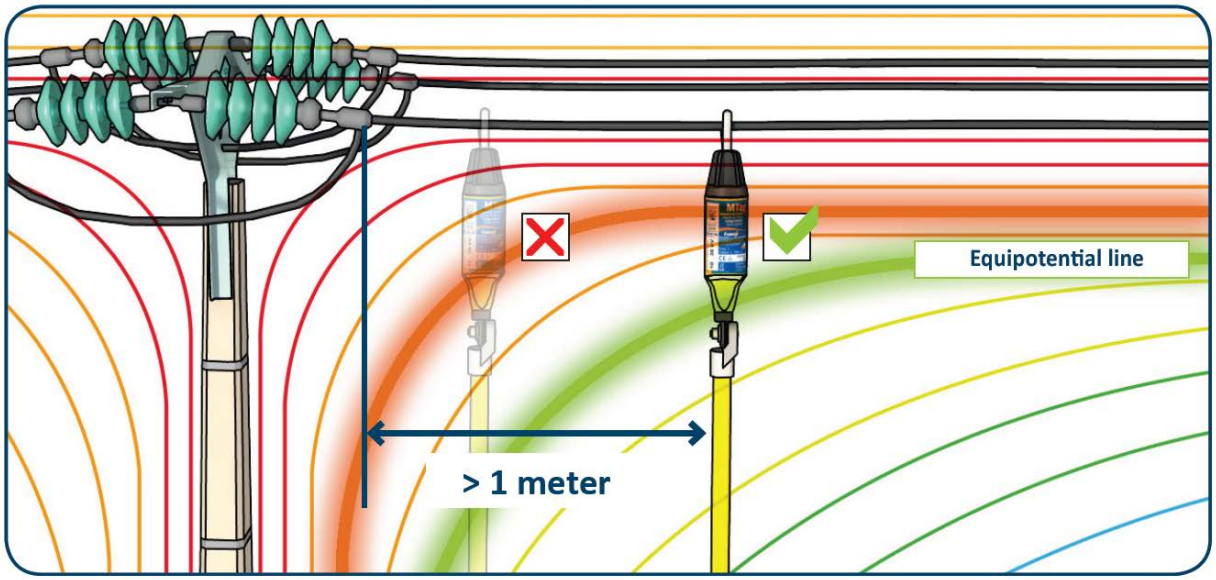
a. The functioning of the tester must be tested by the self-test function for correct operation before and after the test.



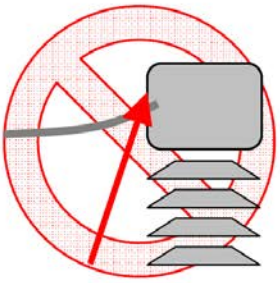
b. The detector must be positioned perpendicular (90 degrees) to the conductor. Otherwise, the top and bottom of the tester would meet closer equipotential lines and may not detect the presence of a voltage:

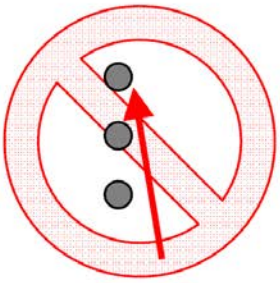


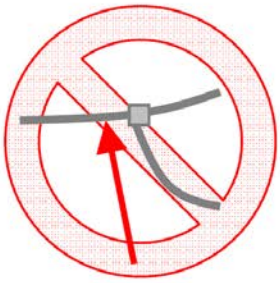
c. The tester must be more than 1 meter from any other conductive objects such as other conductors, hardware, supports, transformers, bridges, droppers, connectors, cable terminations, down leads, etc. These will distort the electric field and compromise the functioning of the tester – it may fail to detect the presence of a voltage:

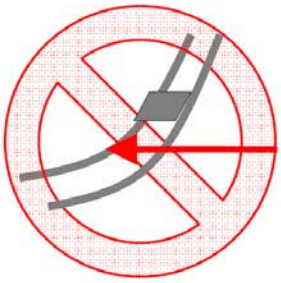


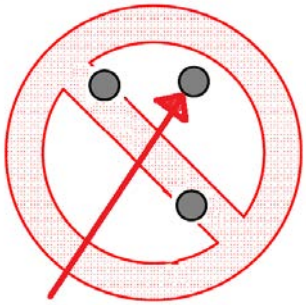
d. Both ends of the tester must be more than 1 meter from any other energised equipment. Adjacent electrical equipment will also distort the electric field, compromising the function of the tester. Examples where this tester cannot be used are shown below:


Insulator Head

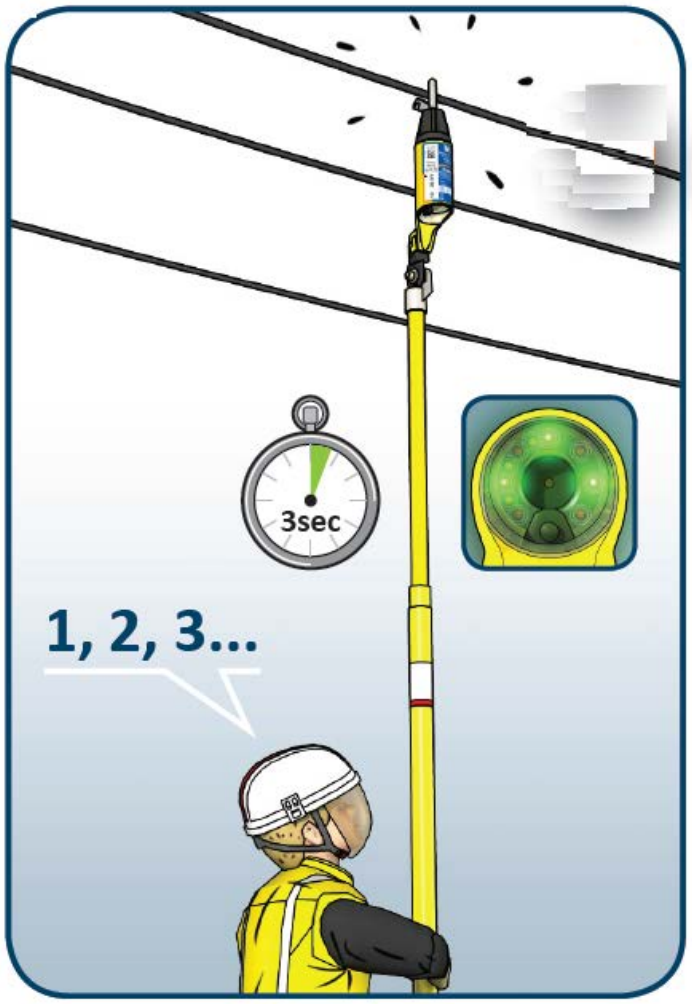

Vertical arrangements


Droppers


Dual Conductors


Delta Arrangements

e. The tester must make good contact for a least 3 seconds for the tester to give a correct indication:



5. This presentation shall be briefed to all Authorised Operators with a signed acknowledgement and returned sent to EDU on the contact EDU contact email by 29 November 2019.

Contact

Electrical Distribution Unit
E: RailElectricalSafety@transport.nsw.gov.au

Engineering Procedure
Electrical Distribution Unit

PR D 78203

High Voltage Operating Procedure

Version 1.2

Date in Force: 19 February 2019

Procedure

Transport Sydney Trains

NSW GOVERNMENT

Approved by:	Nadine Youssef Associate Director Electrical Distribution Unit Engineering System Integrity	Authorised by:	Jonathon McKinnon Engineering Technical Publications Manager System Integrity Unit

Disclaimer

This document was prepared for use by persons in connection with works on or near the rail network electricity system operated by Sydney Trains. Sydney Trains makes no warranties, express or implied, that compliance with the contents of this document shall be sufficient to ensure safe systems or work or operation. It is the document user's sole responsibility to ensure that the copy of the document it is viewing is the current version of the document as in use by Sydney Trains. To the extent permitted by law, Sydney Trains excludes any and all liability for any loss or damage, however caused (including through negligence), which may be directly or indirectly suffered in connection with the use of this document.

Copyright

Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	29 July 2015	Chris Leung	First issue as a Sydney Trains document, rebranded from previous RailCorp SMS-06-EN-0562 V1.2
1.1	10 July 2018	Chris Leung	3 yearly review
1.2	19 February 2019	Nick Loveday	Updated PR D 78203 "Approved by" to Associate Director Electrical Distribution Unit

Summary of changes from previous version

Summary of change	Section

Table of Contents

1 Purpose and scope 4

2 General Requirements 4

2.1 Isolation of High Voltage Equipment 4

2.1.1 Locking and Danger Tags 5

2.1.2 Operating in Substations and Section Huts 5

2.1.3 Changeover Contactors 5

2.2 Operation of Isolating Devices 6

2.2.1 Air Break Switches 6

2.2.2 Isolating Links and Fuse Links 7

2.2.3 Enclosed Switchgear 7

2.2.4 Removal of Jumpers 7

2.3 Proving Dead of High Voltage Equipment 8

2.3.1 High Voltage Cables 8

2.4 Earthing High Voltage Equipment 8

2.4.1 Locations where Earths shall be Applied 9

2.4.2 Earthing Using Portable Earthing Equipment 9

2.4.3 Enclosed Switchgear 10

2.4.4 Earthing Switches – Outdoor Unenclosed 10

2.5 Portable Insulated Operating Sticks 10

2.6 Replacement of HV Fuses 10

3 References 11

1 Purpose and scope

This procedure describes the operating procedures that are applicable to RailCorp's High Voltage (HV) systems.

The HV system includes conductors and equipment with nominal voltages exceeding 1000 volts alternating or 1500 volts direct current. The 1500 volt dc system is not covered by this procedure.

2 General Requirements

The general requirements for electrical operating work stipulated in **PR D 78101 General Requirements for Electrical Work** document, in particular Sections 10 and 11, shall also be complied with.

Operating work shall only be undertaken by specifically authorised persons as described in **PR D 78701 Personnel Certifications – Electrical Authorisations** document. Periodic re-assessment and/or refresher training shall be organised to ensure that these persons are still competent to operate specific switching devices.

Where supplied, the manufacturer's approved operating tools shall be used for undertaking the switching operation.

2.1 Isolation of High Voltage Equipment

HV equipment shall be isolated from all sources that could make it live by providing at least one break in each source.

The RailCorp HV system is generally configured to provide for isolation by a visible break. In some cases, enclosed switchgear providing an equivalent or higher level of security has been approved for use as an isolator. The Local Instructions will indicate where this is the case.

Where a Low Voltage (LV) supply can provide a back feed via a transformer, the supply via that transformer shall be isolated in accordance with **PR D 78401 Isolation and Energisation of Low Voltage Equipment**.

HV isolation shall be provided by means of one or more of the following:

a) Opening air break switches or isolating links.
b) Removal of fuse links or jumpers.
c) Withdrawal of circuit breakers, switches or switch-fuses.
d) Operation of enclosed switchgear to place it in the isolated position.

Warning
An open circuit breaker is not normally a sufficient isolating break. Unless otherwise indicated in the Local Instructions, the circuit breaker shall be withdrawn or the associated air break switch or isolating links opened.

2.1.1 Locking and Danger Tags

The devices providing isolating breaks shall be Danger Tagged in accordance with **PR D 78105 Danger Tags for Electrical Equipment**.

Isolations effected by the operation of the following equipment shall be Danger Tagged by hanging a Special Lock and Danger Tag on the lowest pole step:

a) Isolating links and fuses operated using a portable insulated operating stick.
b) The removal of jumpers.

Where an air break switch provides the isolation, it shall also be locked with a Special Lock (refer to Clause 4 of **PR D 78104 Locking Systems for Electrical Equipment**).

When an isolating device can also be operated by remote control, the remote control shall be made inoperative and the means of ensuring that it remains inoperative shall be Danger Tagged.

2.1.2 Operating in Substations and Section Huts

Operation of equipment in Substations and Section Huts shall be carried out in accordance with Local Instructions.

2.1.3 Changeover Contactors

Mechanically interlocked LV changeover contactors are used to prevent a back feed from one supply to the other. For this reason, they are not considered as a source of supply and do not need to be isolated. However, some mechanically interlocked changeover contactors utilised in substation auxiliary supply arrangements are provided with bypass links (normally removed) primarily to control the risk of loss of auxiliary supply due to failure of the changeover contactor. An inspection shall be carried out to confirm whether such a bypass arrangement exists. In such a case, this bypass circuit shall be considered as a source of supply and the bypass links isolated and Danger Tagged as part of the isolation of the HV equipment.

Generally, **electronic changeover contactors** do not provide the same level of protection against back feed as mechanical changeover contactors do, and shall be treated as sources of supply. Hence, each shall be isolated as part of the isolation of the equipment providing one of the supplies.

Where **electronic changeover contactors are fitted with an auxiliary contactor** in the normal LV supply feeding the electronic changeover contactor, this arrangement prevents a back-feed. Such configurations may be treated in the same manner as a mechanical changeover contactor.

2.2 Operation of Isolating Devices

Operation of all isolating devices shall be carried out under the direction of the Electrical System Operator (ESO).

Warning
An isolating device with a Danger Tag attached shall not be operated.

The Electrical System Operator shall follow the communications protocol described in **PR D 78103 Electrical Operational Communication and Records** when instructing the field operator which isolating device is to be operated and the operation to be undertaken. The field operator shall confirm either that these instructions match the written switching instructions that they have, or they shall record the instructions in writing.

The field operator shall then ensure that the isolating device is the correct one, by checking the location and the label on the isolating device against the written instruction.

The field operator shall also check that the isolating device is in the expected position prior to the operation. In the case of a switch, this shall be done by checking both the blade and handle positions.

The field operator shall then carry out the agreed operation.

After the required operation has been carried out, the field operator shall advise the Electrical System Operator of the operation that has been carried out, following the communications protocol described in procedure **PR D 78103 Electrical Operational Communication and Records**.

2.2.1 Air Break Switches

Except when approval is given by the Electrical System Operator or in emergency conditions, air break switches associated and in series with circuit breakers, shall not be opened unless the associated circuit breaker has been opened. Except when approval is given by the Electrical System Operator, air break switches associated and in series with circuit breakers shall not be closed unless the associated circuit breaker is open.

Warning
Whilst some of the switches are designed to make load or rated currents, they should not be closed onto any section of the electrical network which is suspected to be under fault.

The switching sequence of off-load air break switches that are not in a series configuration with a circuit breaker, shall be carefully planned to ensure that they are not opened to break any load current or paralleling current that the air break switches are not rated to break. This sequence shall be discussed and agreed between the ESO and the field operator. Both parties should refer to the relevant network diagram, agree and record the steps before commencement of switching operation. An example of air break switches without a circuit breaker in series, is in substations having a double busbar arrangement.

Air break switches are to be operated with a single unhesitating movement. A visual check of the blade position shall be made for each phase to ensure the switch has been operated correctly.

This method and sequence of operation also applies for the manual operation of air blast switches that are designed to break rated load currents.

2.2.2 Isolating Links and Fuse Links

HV isolating links and fuse links shall be operated with a single unhesitating movement. When closing, care shall be taken to ensure that the link is closed completely and the safety latch, where fitted, is engaged.

In the case of removable fuse links, once opened, the removable part shall be removed and safely stored. If earths are to be applied at the location, this shall be done prior to applying the earths.

Links in series and associated with air break switches or circuit breakers shall only be opened after the associated air break switches or circuit breakers have been opened. This requirement does not apply to 2kV links and links controlling transformers where the LV switches have been opened.

2.2.3 Enclosed Switchgear

Isolation by any of the following means shall be carried out in accordance with Local Instructions:

a) Withdrawing circuit breakers.
b) Withdrawing switches or switch-fuses.
c) The operation of switchgear to place it in the isolated position.

2.2.4 Removal of Jumpers

Where jumpers are to be removed in order to isolate a HV aerial line or cable, any free ends shall be positively secured so that they cannot come into contact with other conductors or earth.

Isolated conductors shall be separated from live exposed conductors by the minimum fixed clearance distances specified in Table 1.

Voltage	Clearance
Up to and including 33 000 Volts	320 mm
Above 33 000 Volts and up to and including 66 000 Volts	630 mm
Above 66 000 Volts and up to and including 132 000 Volts	1100 mm

Table 1 Minimum Fixed Clearances of Isolated Conductors From Live Exposed Conductors

2.3 Proving Dead of High Voltage Equipment

Each conductor of HV equipment that has been isolated for work shall be proved dead using the approved test voltmeter provided or otherwise as stipulated in the Local Instructions for enclosed switchgear. The proving dead shall be done immediately prior to applying earths and **at each point** where the earths are to be applied.

The test voltmeter shall be selected at the correct range for the voltage being tested. The test voltmeter shall be checked immediately prior to proving dead on known live HV equipment or, if that is not possible, by means of a self-check facility in the test voltmeter. The test voltmeter shall also be checked at the completion of proving dead to ensure that it was functional throughout the proving dead process.

Care shall be taken to ensure that the Safe Approach Distances, set out in **PR D 78700 Working around Electrical Equipment** are maintained.

When HV equipment containing capacitors is being proved dead, sufficient time shall be allowed for the capacitors to discharge.

Proving dead is not required before applying earths to certain types of HV enclosed switchgear where an alternative procedure is stipulated in the Local Instructions.

In the case of HV pole mounted switch frame equipment, with an earthing switch on each side of a fuse, proving dead before earthing is not required provided the LV switch is open, Danger Tagged (refer clause 2.1.1) and a visual check of the HV switch blades has been made to confirm them to be open.

2.3.1 High Voltage Cables

Isolated HV cables shall be proved dead at:

a) The supply point switchgear, and
b) Cable to the overhead line junctions, and
c) Cable to equipment junctions if there is provision for testing at this point.

Before cutting a HV cable, the cable shall be proved dead by spiking at the work site with an approved cable spiking device by a person trained in its use.

Cables shall not be proved dead by spiking when performing:

a) Sheath, screen or serving repairs.
b) Insulation or joint repairs where the cable is not cut.
c) Work on non-concentric cables energised from an unearthed 2kV system.

Under these circumstances, the cable shall be identified by two independent methods.

2.4 Earthing High Voltage Equipment

The general requirements for earthing are described in this section.

Where portable earthing sets are used for earthing purposes, reference should be made to **PR D 78204 Earthing of High Voltage Equipment Using Portable Earthing Equipment**, for more detailed requirements.

2.4.1 Locations where Earths shall be Applied

Isolated and proved dead HV equipment shall be short circuited and earthed at the following locations:

a) Safety earths shall be applied as close as practicable to the points of isolation on each side of a worksite. It is not necessary that the conductors be continuous between the point at which the safety earths are applied and the worksite. In the case of the 11kV system, where a number of sources of supply are connected on one or both sides of the worksite and in close proximity, the source of supply may be considered as being the worksite side of the “Tee” connection closest to the worksite.

b) Working earths shall be applied to all conductors, on which work is being carried out, on each side of the worksite. At least one set of working earths shall be near the work site and positioned to be readily checked. Where Safety Earths are in the work area, they can be considered also as working earths if they are connected to the equipment on which the work is being carried out. All earthed conductors at the worksite shall be connected to a common earth to ensure equipotential conditions.

c) Additional working earths shall be applied where there is a risk of dangerous voltages being induced in the conductors to be worked on from live aerial lines in the area.

d) In the case of a conductive pole or conductive structure that is not connected to an aerial earthwire, the conductors of an aerial line being worked on at that location shall be bonded to the pole or structure prior to any person bridging between the pole or structure and the conductors.

e) A bond shall be applied to bridge the two sides of a conductor that is broken or is to be broken, before bridging by hand. The bridging may be via another unbroken phase or aerial earth conductors.

f) An earth shall be attached to any aerial line conductor that is being lowered to or raised from the ground in the vicinity of other services.

g) When performing cable work, working earths shall be applied at the junctions of cable to equipment or aerial lines, where a section of aerial line exists between the worksite and the point of supply.

h) Prior to making or breaking bridges at a HV cable to HV aerial line junction, working earths and bonds shall be applied to ensure equipotential conditions at the work site.

i) Exposed busbars within substations need only have safety earths applied between the worksite and any source of supply. When the busbar is to be divided into sections, each section shall be short-circuited and earthed before being divided.

j) Busbars of enclosed switchgear shall be earthed at the points indicated in the Local Instructions.

k) If it is necessary to work on an aerial line at a time when there is an increased risk due to lightning, all conductors including aerial earth wires, shall be short-circuited together and earthed at each pole or structure being worked on.

l) Working earths shall be positioned such that there are no fuses between the working earths and the worksite.

2.4.2 Earthing Using Portable Earthing Equipment

Earthing using portable earthing equipment shall be carried out in accordance with **PR D 78204 Earthing of High Voltage Equipment Using Portable Earthing Equipment**.

2.4.3 Enclosed Switchgear

Earthing of enclosed switchgear shall be carried out in accordance with Local Instructions.

If a circuit breaker is used to effect earthing, it shall be made inoperative once the earths have been applied.

2.4.4 Earthing Switches – Outdoor Unenclosed

Immediately prior to closing an earthing switch, each conductor shall be proved dead, except for HV pole mounted switch frame equipment.

Earthing switches are to be operated with a single unhesitating movement. A visual check of the blade position shall be made for each phase to ensure the switch has operated correctly.

HV pole mounted switch frame equipment, with an earthing switch on each side of a fuse, need not be proved dead before earthing provided the LV switch is open and the HV switch blades are visually checked open.

2.5 Portable Insulated Operating Sticks

Portable insulated operating sticks shall be:

a) Labelled as suitable for the voltage.
b) Labelled as purchased or tested within the last 12 months.
c) Inspected for defects prior to use by the operator, as specified in PR D 78107 Insulated Sticks, Tools and Equipment for Electrical Work – Inspection, Testing, Care and Maintenance.
d) Held below the hand guard or mark.
e) Stored correctly after use, as specified in PR D 78107 Insulated Sticks, Tools and Equipment for Electrical Work – Inspection, Testing, Care and Maintenance.

2.6 Replacement of HV Fuses

Operation of HV equipment for fuse replacement shall be carried out under the direction of the Electrical System Operator.

A Substation Access Permit shall be issued for all HV fuse replacement that requires isolation and the application of earths.

A Substation Access Permit is not required for fuse replacement in the following HV equipment:

a) Enclosed switchgear with withdrawable type fuses or switch-fuses that become disconnected equipment when fully withdrawn.
b) Fuses and fuse links that can be removed and replaced using approved portable insulated sticks.

Fuses are to be replaced in accordance with Local Instructions.

3 References

PR D 78101	General Requirements for Electrical Work
PR D 78104	Locking Systems for Electrical Equipment
PR D 78107	Insulated Sticks, Tools and Equipment for Electrical Work – Inspection, Testing, Care and Maintenance
PR D 78204	Earthing of High Voltage Equipment Using Portable Earthing Equipment
PR D 78205	Inspection and Care of Portable Earthing Equipment for the High Voltage System
PR D 78401	Isolation and Energisation of Low Voltage Equipment
PR D 78105	Danger Tags for Electrical Equipment
PR D 78103	Electrical Operational Communication and Records
PR D 78501 FM02	Portable Rail Connection / Earthing Schedule
PR D 78700	Working around Electrical Equipment
PR D 78701	Personnel Certifications – Electrical Authorisations