Transgrid

People. Power. Possibilities.

PSSR Equipment and Tools

Handbook

Power System Safety Rules

This Handbook details approved Power System Safety Rules equipment and tools used for Field Operations, issuing of Access Authorities and other safe work requirements carried out on Transmission lines, Transmission Cables and at Substations.

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

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Author:	J Mason, PSSR Lead/Health Safety & Environment				
Reviewers:	B Wasow, Technical Support Lead/Substations M Gorton, Technical Capability Trainer J Clayton, Senior HSE Business Partner - Electrical D Moore, Technical Capability Delivery Lead W Kroker, Field Coordinator/Substations A Madani, Field Coordinator/Substations T Turnham, Field Coordinator/Substations				
Approver:	J McMurtrie, GM/Health, Safety & Environment				

Introduction

This Handbook details approved Power System Safety Rules equipment and tools used for:

- Field Operations – HV
- Field Operations – LV/MECH
- Issuing Access Authorities on Transmission lines, Transmission Cables and at Substations
- Bridging of earthing

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

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.

There are also similar handbooks for Substations, Transmission Lines, Transmission Cables, Low Voltage Mechanical, Mobile Plant and Field Operations available at:

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

Contents

Introduction **3**

Portable Earthing Equipment **5**

Principles 5
Application of earthing 8
Portable Earthing Applications 9
Approved equipment 10
Earthing systems 17

Proving Safe to Earth Equipment **30**

Approved equipment for various situations 31
Use of HV testers 39
Maintenance 42

High Voltage Operating Rods **43**

Approved equipment 43
Safety 44
Approved applications 45
Procurement 45
Maintenance 46

Additional Field Operating equipment **47**

Access Authority equipment **48**

Safety Observer identification **51**

EWP bonding leads **52**

Change from previous revision **54**

Portable Earthing Equipment

Principles

Applying a portable earth to a HV conductor requires a conductive object to be brought into contact with the HV conductor after it has been proven safe to earth.

- Portable earthing is initially only applied to HV conductors by persons authorised:
  - Operate HV Apparatus - Connection Point
  - Operate HV Apparatus – Advanced
  - Issue Field Access Authority
- Portable earthing used for bridging of earthing is only applied and removed by persons authorised:
  - Bridge Earthing TL Structure
  - Bridge Earthing Grids
- After cancellation of a Field Access Authority, portable earthing is removed by persons authorised:
  - Receipt of a Field Access Authority
- During a HV Access Authority, to control induced voltages and currents, working earths may be applied to unearthed conductors by persons authorised:
  - Operate HV Apparatus – Advanced
- During a HV Testing Access Authority, earthing may be removed and re-applied in the same position by persons authorised:
  - Receipt of a HV Testing Access Authority

Safety

Handling earthing equipment in substations or near transmission lines:

- Always carry earthing equipment below shoulder level ensuring that clamps and leads are kept a safe distance from HV conductors;
- Assemble and inspect earthing equipment on the ground; and
- Extend or otherwise prepare any earthing equipment such as shot gun sticks on the ground.

Applying Portable Earths

HV conductors must be proven safe to earth (de-energised) before the initial application of earthing.

1. Connection at the earth end point must be performed prior to any connection to a conductor;
2. During application, earthing equipment must not encroach on, or come into contact with adjacent live HV conductors;
3. Where practicable, keep the earthing leads away from the body;
4. Apply clamps to stirrup (if provided) or a horizontal conductor where possible;
   a. Avoid clamp application to bushing caps and to braids;
   b. Position the clamp so that tension on the earth lead is minimised; and
   c.
   d. Confirm clamp is firmly attached by shaking lead.

Removing Portable Earths

- Portable earths must be disconnected from all conductors prior to being disconnected from the earth end point;
- Earthing equipment must be removed carefully from HV conductors to prevent it from encroaching on, or coming into contact with adjacent live HV conductors.

Discharging HV Apparatus

Where HV apparatus such as capacitor banks will discharge through the earthing system, sufficient time must be allowed between de-energising of the conductors and the application of any earthing to permit any residual charge to be dissipated.

Equipment that Experiences a Fault

Any portable earthing equipment that experiences a fault or over current must be withdrawn from service immediately.

Application Accessories

Portable earthing must be installed using approved applicators suitable for the task.

Rating

Confirm that the rating of the earthing equipment is appropriate for the fault level at the location at which it is to be applied.

The equipment used for earthing must have a fault withstand rating greater than that of the location in which it is used. Information about the expected fault currents and back-up protection times at particular locations is available from Network Operations.

Where the fault rating of the location exceeds that of the equipment, multiple sets may be used to increase the rating of the earthing system:

- In switchyards this information will be included on the High Voltage Preparation and Restoration Instruction (HVPRI).

```
SS8    912 Port Hacking Bus Disconnector.. 9123  -CHECK OPEN
                                                -LOCK & APPLY DO NOT OPERATE
                                                 TAG(S)

Earthing
--------

SS9    Conductors between                        -PROVE DE ENERGISED
       912 Port Hacking C.B.. 9122               -EARTH (2 SETS)
       and                                      -APPLY WARNING TAG(S)
       912 Port Hacking Bus Disconnector.. 9123

SS10   Conductors between                        -PROVE DE ENERGISED
       912 Port Hacking C.B.. 9122 C.T.(s)       -EARTH (2 SETS)
       and                                      -APPLY WARNING TAG(S)
       912 Port Hacking Line Disconnector.. 9121

SS11   ADVISE CONTROLLER  WHEN THE PREVIOUS STEP IS COMPLETED
                                                                    ...HRS
```

- On transmission lines where the fault rating of the line exceeds the fault rating of the earthing set, multiple sets of MT 815S clamps and associated earth end clamps may be used.

Equipment and Connections

- Check that the earthing system is complete, in good condition and has an in-date tag confirming it has been tested for electrical conductivity within the last 3 years.
    - Any portable earthing equipment found to be defective must be removed from service for repair or disposal.
- Check that all bolted connections are tight, and that any electrical connection is positive and mechanically sound.
- Ensure that leads are sufficiently long for the task.

Application of earthing

Applying earthing from an EWP

After being proven safe to earth, the HV conductors may still be subject to significant induced or transferred voltages. During application of earthing for 220kV, 330kV and 500kV conductors the authorised person's body or uninsulated parts of the EWP must not approach closer than 2,000mm to the unearthed HV conductors.

> For voltages lower than 220kV, Transgrid's Safe Approach Distances (Mobile Plant+) apply.

Normal Safe Approach Distances must be maintained to any other HV conductors in the vicinity of the earthing process (e.g. adjacent bays in substations or the other circuit on a double circuit transmission line).

Switchyards

Connection to Earth End Point

Earthing stubs must be used for all earth end connections within switchyards. Ensure that the stub is not corroded and that it is securely mounted on the structure. CATU MT-815S clamps must be used with earth stubs and the clamp should be applied with a MT-815S application handle.

Indoor Switchgear

Connection to Earth End Point

Ball stubs are sometimes used where the fault rating of the indoor switchgear is less than or equal to the 25 kA 0.5 second rating. Ensure that the stub is not corroded and that it is securely mounted on the structure. Pfisterer 360333333 clamps must be used with these ball stubs and the clamp is applied with a CM-710-E application handle.

Transmission Lines

Connection to Earth End Point on Steel Towers

For steel tower earthing systems, the tower itself is used as the earth point. CATU MT-847 surface penetrating clamps must be used on painted or galvanised surfaces, attached to a flat part of the tower structure and screwed up as tightly as practicable by hand.

Connection to Earth End Point on Wood or Concrete Poles

Pole earthing systems involve the use of both the pole earth and an independent temporary earth electrode (earth stake). The earth stake is positioned approximately 1.3m from the pole and driven 600mm into the ground then bonded to the pole earth using a standard portable earth lead with MT-815S clamps which should be applied with a MT-815S application handle.

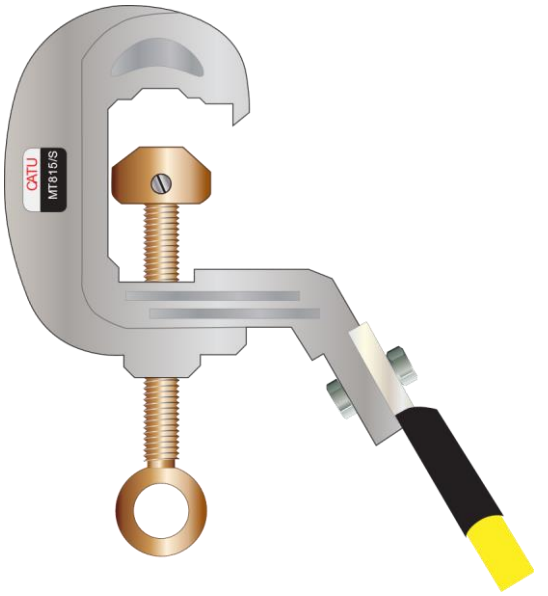
Portable Earthing Applications

Situations	Line End			Earth End		
	Connection	Clamp	Application	Connection	Clamp	Application
Switchyards	Stirrup or conductor	MT-815-S	Shotgun Stick	Earth Stub	MT-815S	MT-815S applicator
		MT-815-E	CATU CM-4130-E applicator			
		MT-701	Haulage and Release Cord			
Steel Tower Transmission Lines	Conductor	MT-815-S	Shotgun Stick	Tower Structure	MT-847	Hand
		MT-815-E	CATU CM-4130-E applicator			
		MT-701	Haulage and Release Cord			
Wood and Concrete Pole Transmission Lines	Conductor	MT-815-S	Shotgun Stick	Earth stake bonded to pole earth	MT-815S	MT-815S applicator
		MT-815-E	CATU CM-4130-E applicator			
		MT-701	Haulage and Release Cord			
Indoor Switchgear	Stirrup or conductor	MT-815-S	Shotgun Stick	Earth Stub	MT-815S	MT-815S applicator
				Ball stub	Pfisterer 360333333	CM-710-E applicator
Mobile Plant	Earth Stub on chassis	MT-815-S	MT-815-S applicator	Earth Stub	MT-815S	MT-815S applicator
	Direct to chassis or boom	MT-847	Hand	Earth Stub	MT815S	MT-815S applicator
				Tower Structure	MT-847	By Hand
				Earth stake	MT815S	MT-815S applicator
Earthing Grid Bridging	Earthing grid	MT-815-S	MT-815-S applicator	Earthing grid	MT-815S	MT-815S applicator

Approved equipment

The portable earthing equipment detailed in this section is approved for use on Transgrid's Power System.

Screw Action Clamp MT-815-S	
Approved Rating	40 kA/0.5 seconds
Use	Line or Earth end connections for Earthing and Bridging
Limitations of Use	Round Conductor up to 44mm in diameter, Flat Conductor from 3mm to 40mm in thickness
Stockcode	3180437
Associated Equipment	Shotgun Stick or MT-815S applicator



Screw Action Clamp MT-815-E	
Approved Rating	25 kA/0.5 seconds
Use	Line end connections
Limitations of Use	Round Conductor up to 44mm in diameter, Flat Conductor from 3mm to 40mm in thickness
Stockcode	000361248
Associated Equipment	CM-4130-E application stick

Snap Action Line Clamp MT-701	
Approved Rating	40 kA/0.5 seconds
Use	Line end earthing connections only
Limitations of Use	Round Conductors 20 to 40 mm diameter
Stockcode	986968 each 986901 complete set with single leads 986893 complete set with twin leads
Associated Equipment	Haulage and Release Cord Sandbag Ezyhook

Arming the MT-701 clamp:

5. Lay the clamp on the ground so that the tail of the tongue points vertically upwards.
6. Holding the earth lead in one hand to stabilise the clamp, use the heel of your boot to compress the tongue down against the body of the clamp until it latches.
7. Ensure that the clamp is securely latched before handling.

Applying the MT-701:

1. Arm the clamp;

Pass the haulage cord over the conductor or through the stirrup by the using an Ezyhook or sandbag;

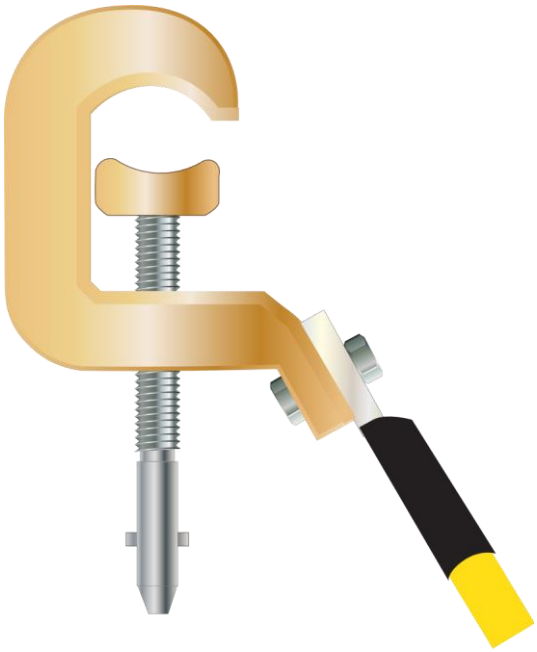
2. Hoist the clamp to the conductor using the haulage cord; then
3. Latch the clamp to the conductor with a quick pull on the cord.

Removing the MT-701:

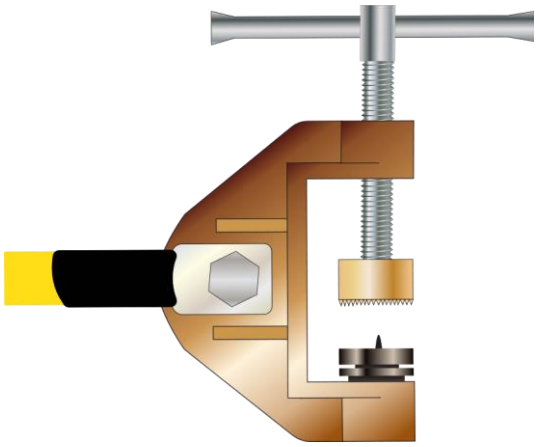
1. Take the weight of the clamp and lead on the haulage cord;
2. Pull the release cord until the clamp releases from the conductor;
3. Lower the clamp and lead/s on the haulage cord; and
4. Pull the haulage cord over the conductor or through the stirrup.

Haulage and Release Cord	
Approved Rating	N/A
Use	Application accessory
Limitations of Use	MT-701
Drawing Number	STD-647195
Stockcode	987321 (18m) 3592383 (9m)
Associated Equipment	Snap Action Line Clamp MT-701 Sandbag Ezyhook

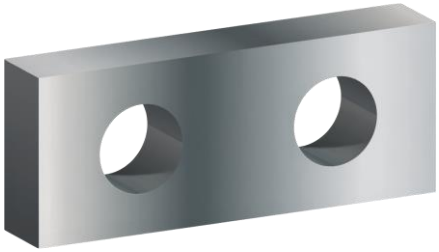
Multipurpose line clamp – Pfisterer 360 333 333	
Approved Rating	25 kA/0.5 seconds
Use	Earth end connections
Limitations of Use	Indoor Switchgear with ball stubs as the earth end connection.
Stockcode	Not stocked - Contact Transgrid Stores for supplier information
Associated Equipment	CM-710-E application handle

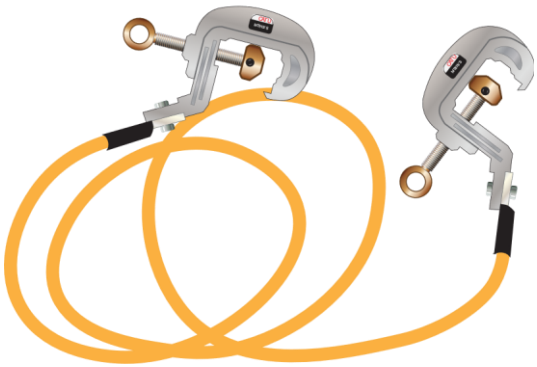


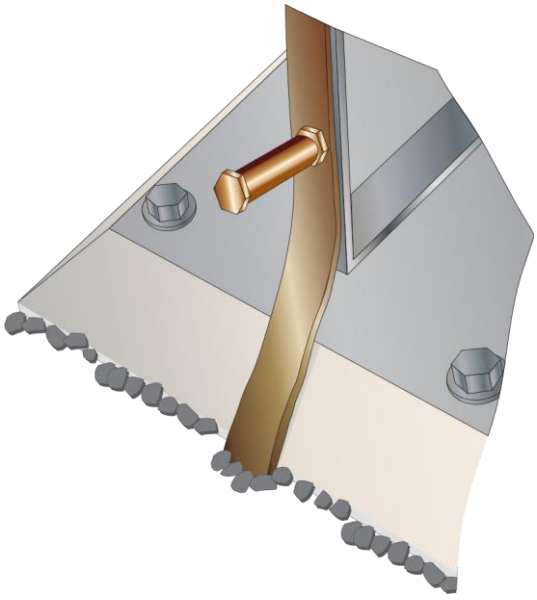
Surface Penetrating Clamp MT-847	
Approved Rating	25 kA/0.5 seconds
Use	Earth end earthing connections on painted or galvanised steel and Mobile Plant
Limitations of Use	Maximum parallel flat plate 5 to 30 mm thick
Drawing Number	STD-647162
Stockcode	3512027
Associated Equipment	Nil

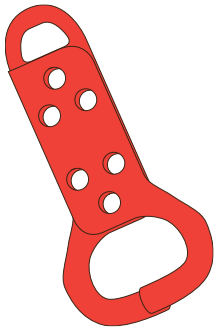


Trifurcating Plate	
Approved Rating	25 kA/0.5 seconds
Use	Polyphase earthing systems
Limitations of Use	-
Drawing Number	STD-647176
Stockcode	986844
Associated Equipment	Earthing leads

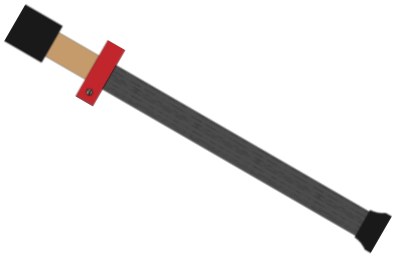


Portable Earth Lead 125mm2 - 130mm2		
Approved Rating	25 kA/0.5 seconds – Single Lead 40 kA/0.5 seconds – Twin Leads	
Use	Any Earthing, Bridging or Bonding situations	
Limitations of Use	Where fault rating is exceeded, twin leads or multiple sets are to be used.	
Stockcode	003591849 1m 000986810 7m 000986885 9m 000986828 19m	
Associated Equipment	All Clamps	
Notes	All lengths of lead meet the fault ratings above. The continuous current rating of both lead types is 300 Amps. Portable earthing leads must be yellow in colour.	

Earthing Stub		
Approved Rating	40 kA/0.5 seconds	
Use	Structure earth point	
Limitations of Use	Used only with MT815S clamp	
Drawing Number	STD-647067	
Stockcode	3512472	
Associated Equipment	MT815S clamp	

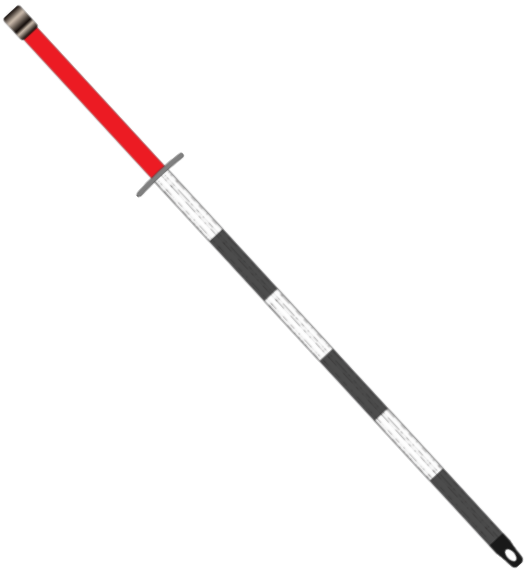
Lockout hasp		
Use	Earthing grid bridging	
Limitations of Use	Used only with MT815S clamp	
Drawing Number	-	
Stockcode	0360470	
Associated Equipment	MT815S clamp	

MT-815-S applicator	
Approved Rating	Not applicable
Use	Earthing, bridging or bonding
Limitations of Use	MT-815-S clamp
Stockcode	3512449
Associated Equipment	MT-815-S Clamp



CM-710-E applicator	
Approved Rating	N/A
Use	Earthing
Limitations of Use	Pfisterer 360 333 333 clamp
Stockcode	Not stocked - Contact Transgrid Stores for supplier information
Associated Equipment	Pfisterer 360 333 333 clamp

CM-4130-E Application Handle	
Approved Rating	N/A
Use	Application of MT-815-E clamps
Limitations of Use	MT-815-E clamps
Stockcode	000361249
Associated Equipment	MT-815-E clamps

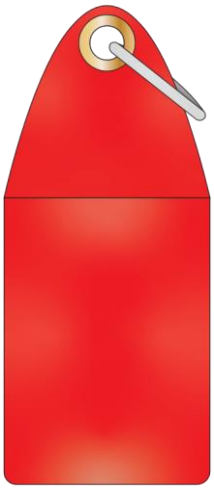


Shotgun Stick	
Approved Rating	N/A
Use	Application of MT-815S clamps
Limitations of Use	MT-815S clamps
Stockcode	3512498
Associated Equipment	MT815S clamp

Independent temporary earth electrode (Earth Stake)	
Approved Rating	40 kA/0.5 seconds
Use	Transmission Line earth end connection point
Limitations of Use	Used only with MT815S clamp
Drawing Number	STD-647252
Stockcode	3512464
Associated Equipment	MT815S clamp

Ezy Hook	
Approved Rating	Not applicable
Use	Earthing
Limitations of Use	-
Stockcode	364238
Associated Equipment	HV Operating Rod

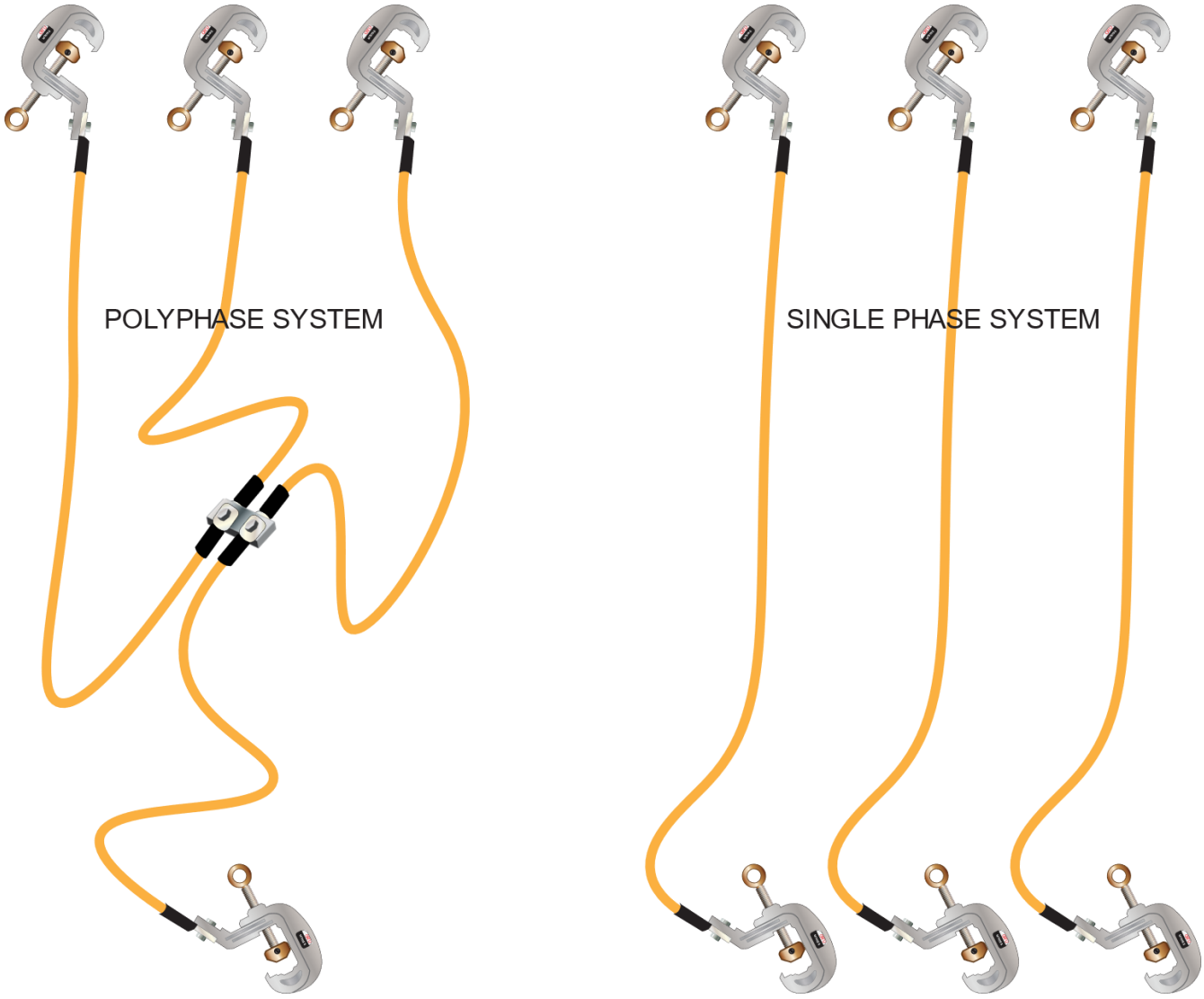
Sandbag	
Approved Rating	Not applicable
Use	Earthing
Limitations of Use	MT-701 hauling lead
Stockcode	Not stocked - Contact Transgrid Stores for supplier information
Associated Equipment	HV Operating Rod Link adaptor fitting



Earthing systems

An earthing system is a recognised set of components to perform the function of earthing. The components are assembled into either polyphase or single phase earthing systems. An earthing system comprises:

- Line end clamp or clamps
- earthing leads
- earth end clamp or clamps
- possibly a short circuiting point (trifurcating plate)
- connecting hardware
-

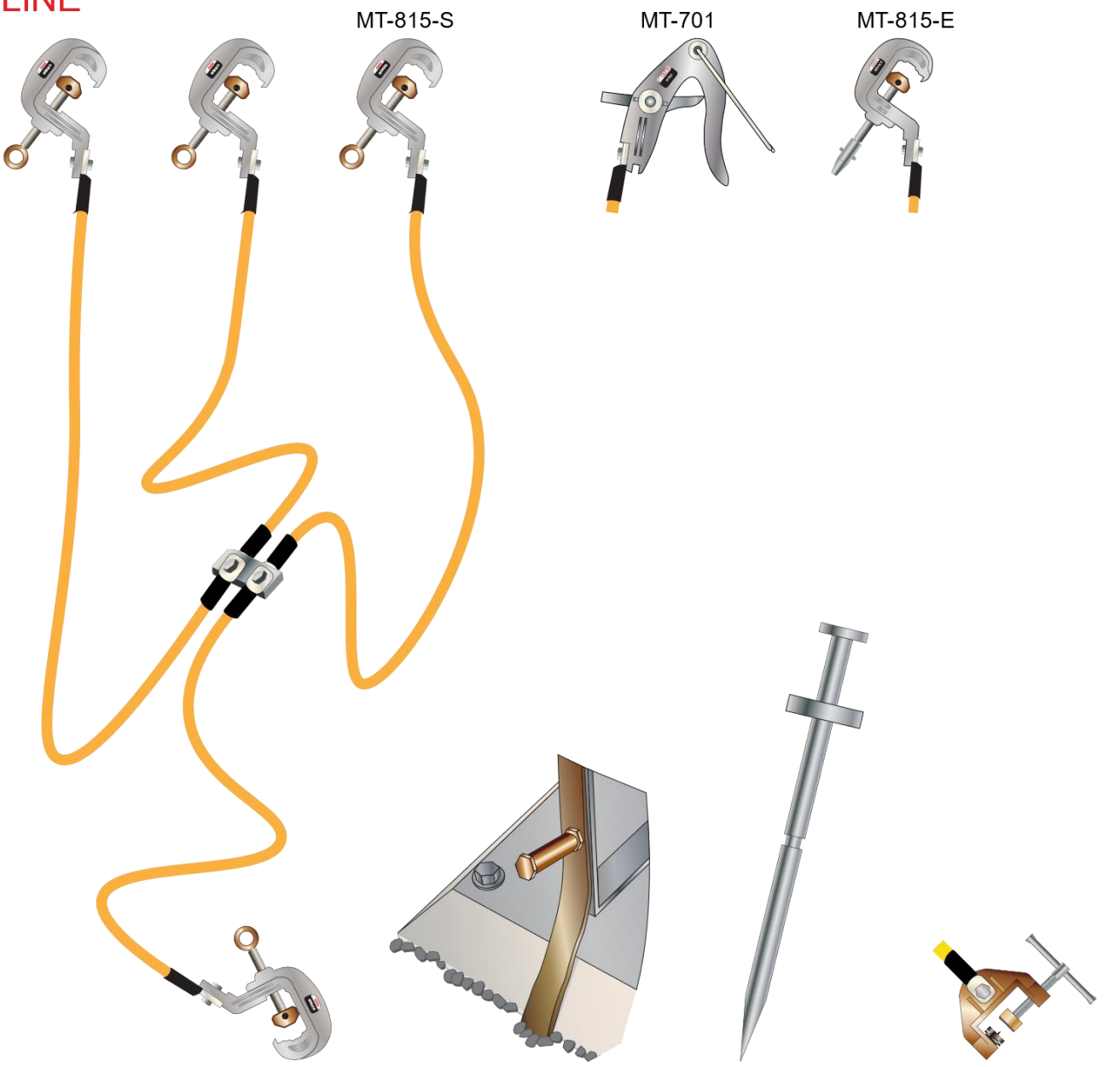


Three phase earth systems are normally used when earthing conductors. It is not acceptable to earth only the phase/s on which work is being performed.

The following earthing systems including alternative clamps arrangements are approved for use on Transgrid's Power System.

Trifurcated Earth System

LINE

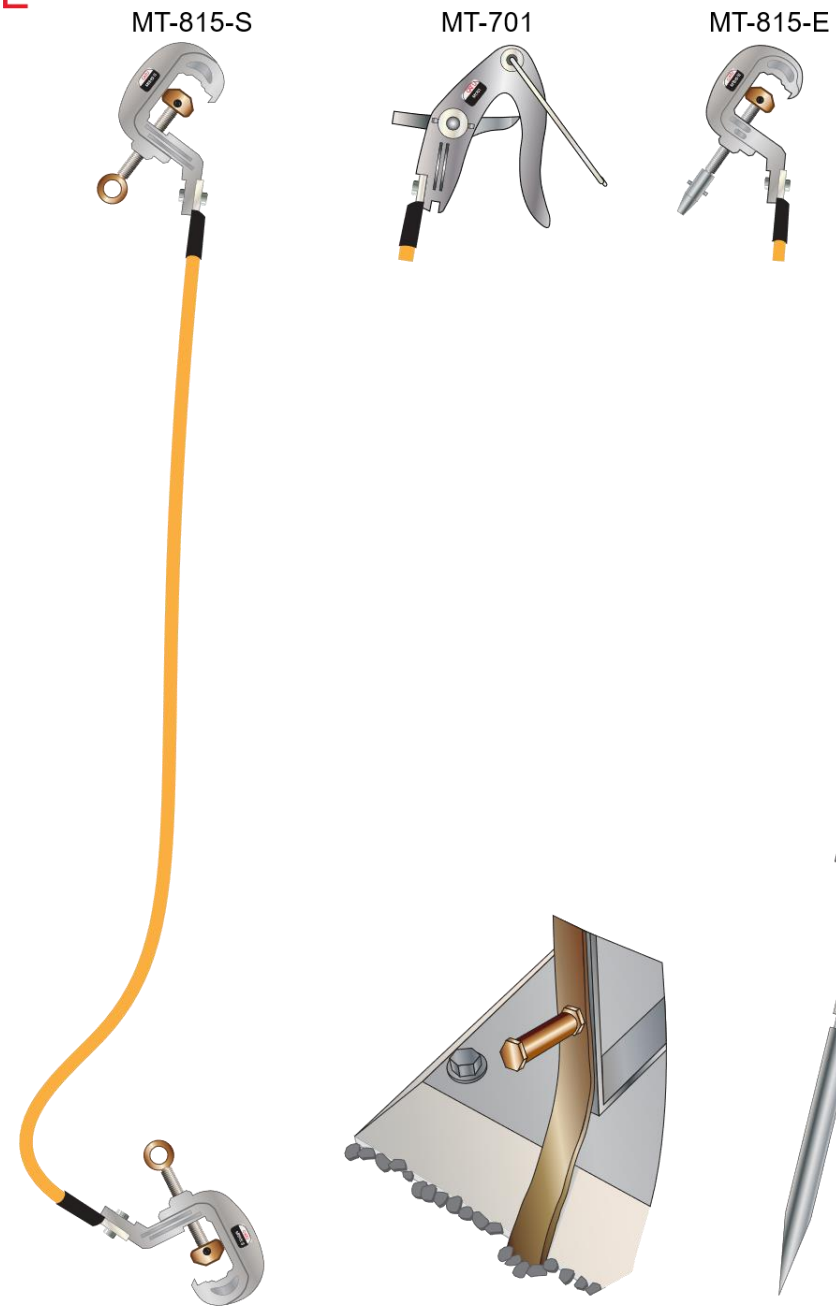


EARTH

Approved Rating 25 kA/0.5 seconds

Single Phase, Single Lead Earth System

LINE



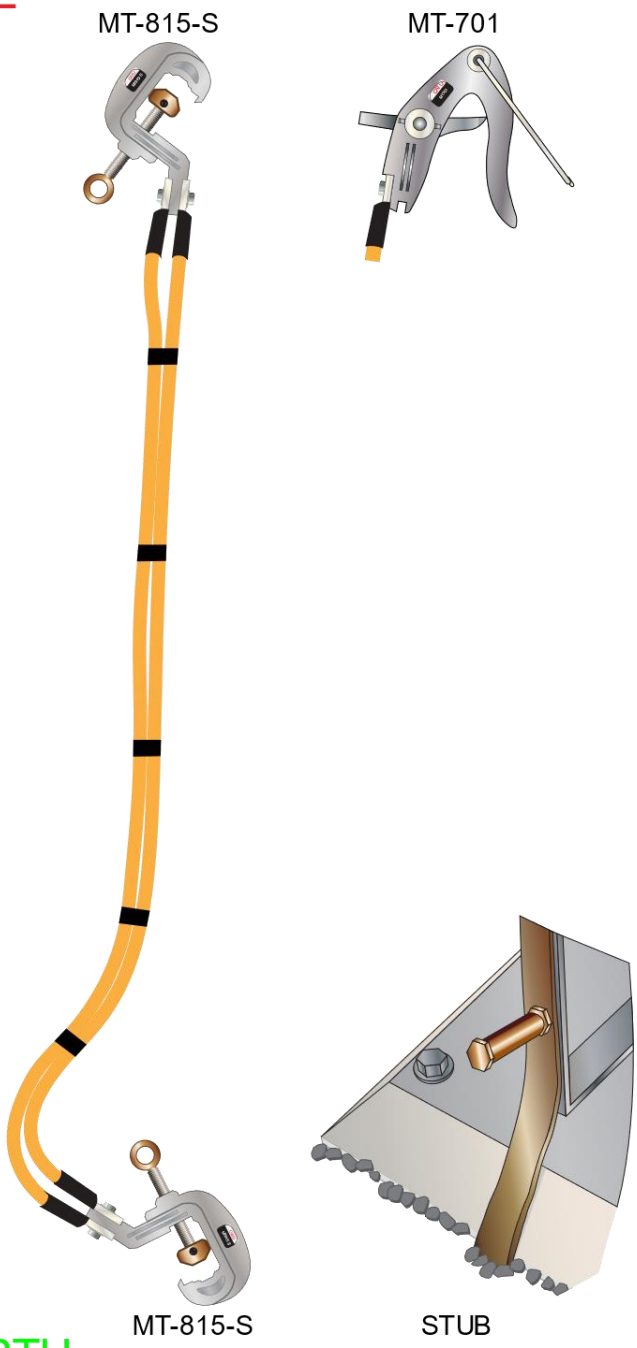
EARTH

Approved Rating 25 kA/0.5 seconds

Three sets must be used to earth all three phases.

Single Phase, Twin Lead, Single Clamp Earth System

LINE



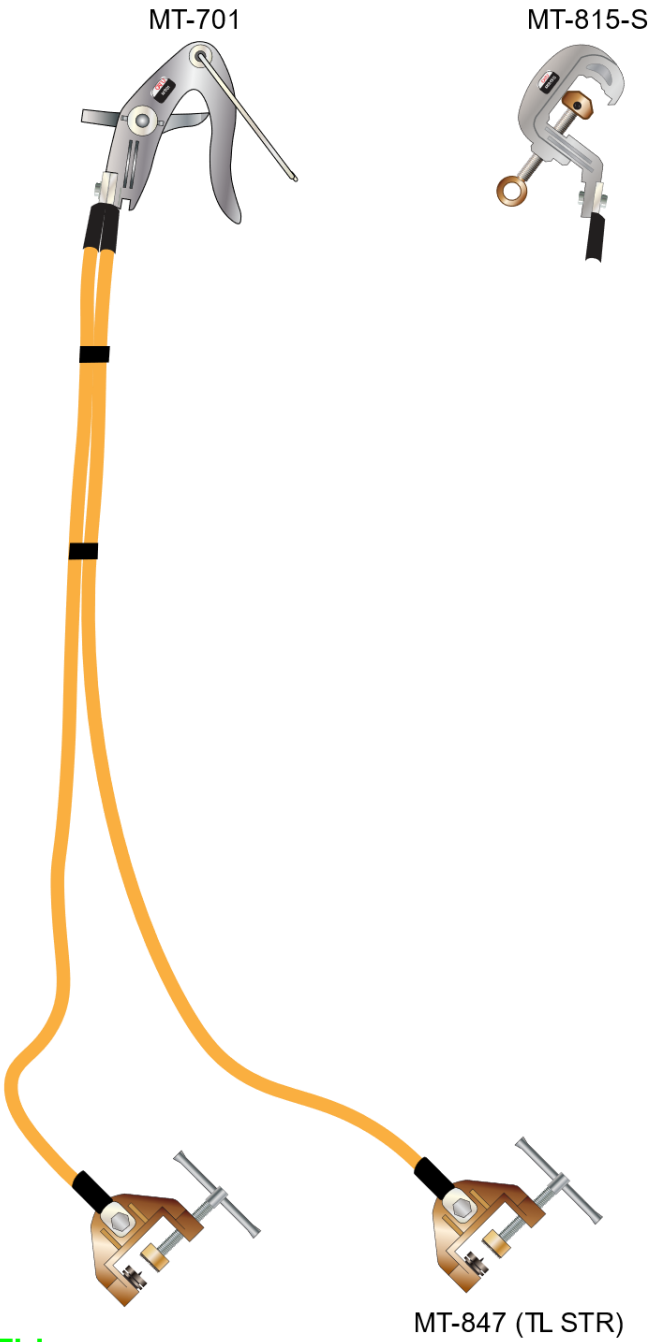
EARTH

Approved Rating 40 kA/0.5 seconds

Three sets must be used to earth all three phases.

Single Phase, Twin Lead, Twin Clamp Earth System – Transmission Line steel structure

LINE



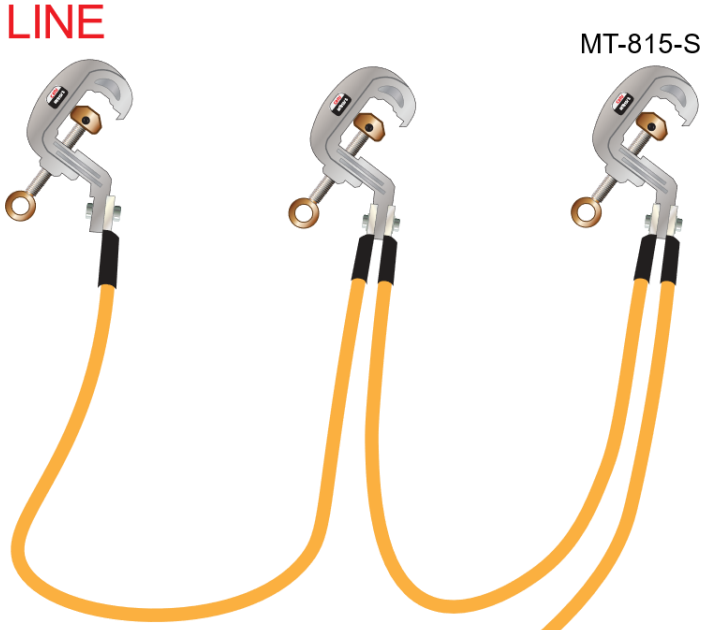
EARTH

Approved Rating 40 kA/0.5 seconds

Three sets must be used to earth all three phases.

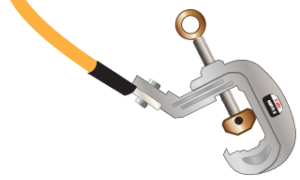
Bridge Method

LINE

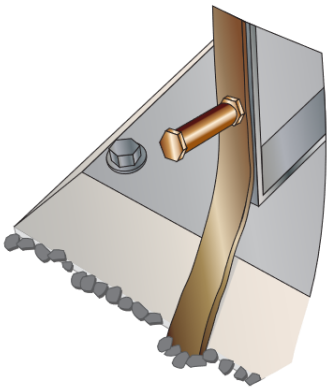


MT-815-S

MT-815-E



MT-815-S



STUB

Pfisterer to Ball stub

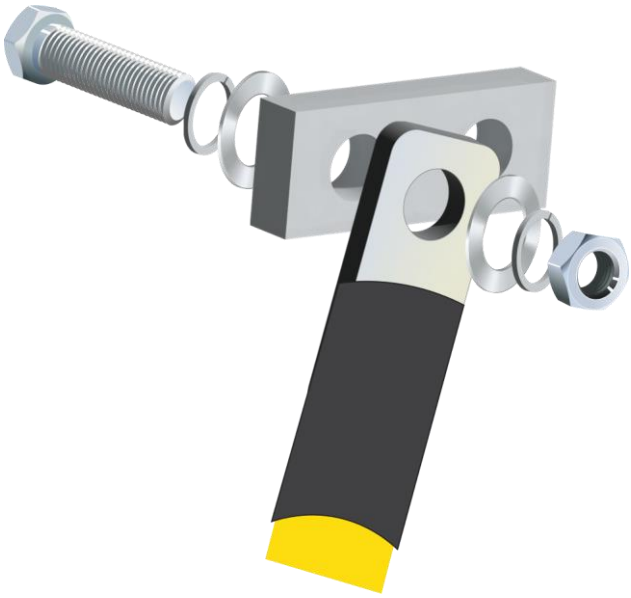
EARTH

Approved Rating 25 kA/0.5 seconds

Assembly

When connecting components, use only stainless steel connecting hardware in the following order:

- Stainless steel (SS) set screw;
- flat washer;
- items to be connected (e.g. lug to trifurcating plate); then
- SS flat Washer;
- SS spring washer; and
- SS nut.



When assembling the hardware, the contact areas of the lugs, clamps and trifurcating plate must be scratch brushed and coated with Alminox or equivalent jointing compound prior to connection of the earth leads. The bolts or screws must be tightened to a torque of 60 Nm and any excess compound wiped off.

Traceability

A register of all portable earthing equipment must be maintained by their relevant custodians. The register must contain the equipment type, location, unique identification number and date when the earthing device was last maintained and tested.

Each component must have a unique identifier that is not to be re-used even if the component is subsequently withdrawn from service. Marking must be permanent, indelible and not interfere with the functionality or integrity of the component. Fault rating identification, current and duration, is to be included on leads.

Storage

All portable earthing equipment should be stored so the effects of weathering are minimised. Earth leads, with clamps permanently connected must be rolled up, and stored in cubicles or indoors.

Application handles such as shotgun sticks are to be stored indoors or within vehicles.

Disposal

Earthing equipment that has become unsalvageable may be scrapped.

Maintenance

The relevant equipment custodian must ensure all portable earthing equipment is inspected and tested every three years for damage, condition and electrical conductivity. Equipment that fails inspection or test must be removed from service for repair or disposal. Repaired equipment must only be returned to service after passing inspection and any specified test.

Inspection and maintenance of earthing equipment

Equipment	Physical inspections	Measurements	Maintenance
Earthing Leads	• Cable sheath is intact with no score marks, cuts or tears along its length; • Heat shrink is sound in its sealing of both the lug and the cable; and • Check lugs for elongation of hole, corrosion, pitting or flaking of the contact surfaces.	Voltage drop	• Any lead failing tests or requiring repairs must either be: - Replaced if not satisfactory; or - Tested for voltage drop after the repair is completed. • Tears in the sheath where conductor strands are not damaged may be repaired with heat-shrink tubing in conjunction with a sealant. • Problems with the lugs or terminations are to be repaired by re-terminating the lead.
Clamps	• Clamp body is intact with no signs of mechanical damage or corrosion; and • Moving parts operate freely and free of corrosion, shafts not bent, threads in good order, welds or brazing solid.	Nil	• The springs of snap action earthing equipment may require lubrication with grease to prevent corrosion. • Handles or spindles from otherwise damaged clamps may be salvaged and kept for use as spares for repairs to other clamps. Parts from different types of clamps are not be intermixed.
Shotgun sticks	• Fibre glass body and extension are intact and free from cracks or chips; • No evidence of moisture exists with the telescopic section fully extended; • All locking devices operate correctly and are not badly scored or gouged; • Check metal parts for corrosion; • Hook mechanism operates freely and locks into position and the release mechanism operates correctly; and	Nil	• Lubricate sectional stick metal locking devices. • Clean fibreglass exterior on all sticks and telescoping sections of telescopic stick. • If parts are damaged then contact the supplier for spares or replace stick. • If fibreglass is damaged superficially, repair with a fibreglass repair kit.

Equipment	Physical inspections	Measurements	Maintenance
	• Hook is firmly attached to the shaft of the stick and is not damaged or bent		
Earth Stub	• Ensure stub does not have signs of mechanical wear or corrosion; and • Check tightness of stub onto copper strap.	Nil	• If stub cylindrical surface or electrical contact surface is mildly scored then clean with abrasive paper and/or file as necessary. • Tighten Stub onto copper strap with spanner if necessary ensuring mating surfaces are clean.
Clamp applicators	• Check handle for cracks and degrading of material; and • Clamps can be securely held in an inverted position	Nil	• Replace if not satisfactory
Trifurcating Plate	• Ensure all surfaces are free from the effects of corrosion or mechanical damage. Check connection holes are clear to accept set screw	Nil	• Replace if not satisfactory
Connecting hardware	• Check for damage.	Nil	• Replace any item that shows signs of corrosion. • Lubricate as necessary
Haulage & Release Cords	• Check outer sheath for damage or ingress of moisture. • Sister clip or dog clip connections intact	Nil	• Replace if not satisfactory
Earth Stake	• Ensure integrity of stake material and welds	Nil	• Replace if not satisfactory

Earthing lead voltage drop tables

Maximum Permissible Voltage Drop For Earth Leads

Lead: 125 sq mm - 250 Amps

Lead Length metres	Table of Lead Voltage Drop vs Temperature of Lead in Degrees Celsius			
	10	20	30	40
4	0.247	0.257	0.267	0.277
4.2	0.26	0.27	0.281	0.291
4.4	0.272	0.283	0.294	0.305
4.6	0.284	0.296	0.307	0.319
4.8	0.297	0.309	0.321	0.333
5	0.309	0.322	0.334	0.347
5.2	0.321	0.334	0.347	0.361
5.4	0.334	0.347	0.361	0.374
5.6	0.346	0.36	0.374	0.388
5.8	0.358	0.373	0.388	0.402
6	0.371	0.386	0.401	0.416
6.2	0.383	0.399	0.414	0.43
6.4	0.396	0.412	0.428	0.444
6.6	0.408	0.424	0.441	0.458
6.8	0.42	0.437	0.454	0.471
7	0.433	0.45	0.468	0.485
7.2	0.445	0.463	0.481	0.499
7.4	0.457	0.476	0.494	0.513
7.6	0.47	0.489	0.508	0.527
7.8	0.482	0.502	0.521	0.541
8	0.494	0.515	0.535	0.555
8.2	0.507	0.527	0.548	0.568
8.4	0.519	0.54	0.561	0.582
8.6	0.532	0.553	0.575	0.596
8.8	0.544	0.566	0.588	0.61
9	0.556	0.579	0.601	0.624
9.2	0.569	0.592	0.615	0.638
9.4	0.581	0.605	0.628	0.652
9.6	0.593	0.617	0.641	0.666
9.8	0.606	0.63	0.655	0.679
10	0.618	0.643	0.668	0.693
10.5	0.649	0.675	0.702	0.728
11	0.68	0.707	0.735	0.763
11.5	0.711	0.74	0.768	0.797
12	0.742	0.772	0.802	0.832
12.5	0.773	0.804	0.835	0.867
13	0.803	0.836	0.869	0.901
13.5	0.834	0.868	0.902	0.936
14	0.865	0.9	0.935	0.971
14.5	0.896	0.933	0.969	1.005
15	0.927	0.965	1.002	1.04
16	0.989	1.029	1.069	1.109
17	1.051	1.093	1.136	1.179
18	1.112	1.158	1.203	1.248
19	1.174	1.222	1.27	1.317
20	1.236	1.286	1.336	1.387
25	1.545	1.608	1.671	1.733
30	1.854	1.929	2.005	2.08

Maximum Resistance of Lead at 20 degrees C	0.245 **mohm/m**	alpha =	0.0039 for Aluminium
Based on a Full Wave Rectified DC Current of	250 **Amps**	Ro	0.245 mOhm @ 20 deg C
These figures include an error of	5 **%**		
Equation Used for Calculation of Voltage Drop Variation with Temperature:		V = I * Rt * Lead Length * 1.05 (error)	
Equation used to Calculate Resistance at temp t		Rt = Ro(1 + alpha*td) td = diff in temp from ref	

Maximum Permissible Voltage Drop For Earth Leads

Lead: 130 sq mm - 250 Amps

Lead Length metres	Table of Lead Voltage Drop vs Temperature of Lead in Degrees Celsius			
	10	20	30	40
4	0.236	0.246	0.255	0.265
4.2	0.248	0.258	0.268	0.278
4.4	0.26	0.27	0.281	0.291
4.6	0.272	0.283	0.294	0.305
4.8	0.283	0.295	0.306	0.318
5	0.295	0.307	0.319	0.331
5.2	0.307	0.319	0.332	0.344
5.4	0.319	0.332	0.345	0.358
5.6	0.331	0.344	0.357	0.371
5.8	0.342	0.356	0.37	0.384
6	0.354	0.369	0.383	0.397
6.2	0.366	0.381	0.396	0.411
6.4	0.378	0.393	0.408	0.424
6.6	0.39	0.405	0.421	0.437
6.8	0.401	0.418	0.434	0.45
7	0.413	0.43	0.447	0.464
7.2	0.425	0.442	0.46	0.477
7.4	0.437	0.455	0.472	0.49
7.6	0.449	0.467	0.485	0.503
7.8	0.46	0.479	0.498	0.516
8	0.472	0.491	0.511	0.53
8.2	0.484	0.504	0.523	0.543
8.4	0.496	0.516	0.536	0.556
8.6	0.508	0.528	0.549	0.569
8.8	0.519	0.541	0.562	0.583
9	0.531	0.553	0.574	0.596
9.2	0.543	0.565	0.587	0.609
9.4	0.555	0.577	0.6	0.622
9.6	0.567	0.59	0.613	0.636
9.8	0.578	0.602	0.625	0.649
10	0.59	0.614	0.638	0.662
10.5	0.62	0.645	0.67	0.695
11	0.649	0.676	0.702	0.728
11.5	0.679	0.706	0.734	0.761
12	0.708	0.737	0.766	0.795
12.5	0.738	0.768	0.798	0.828
13	0.767	0.799	0.83	0.861
13.5	0.797	0.829	0.862	0.894
14	0.826	0.86	0.893	0.927
14.5	0.856	0.891	0.925	0.96
15	0.885	0.921	0.957	0.993
16	0.944	0.983	1.021	1.059
17	1.004	1.044	1.085	1.126
18	1.063	1.106	1.149	1.192
19	1.122	1.167	1.213	1.258
20	1.181	1.229	1.276	1.324
25	1.476	1.536	1.596	1.655
30	1.771	1.843	1.915	1.986

Maximum Resistance of Lead at 20 degrees C	0.234 **mohm/m**	alpha =	0.0039 for Aluminium
Based on a Full Wave Rectified DC Current of	250 **Amps**	Ro	0.234 mOhm @ 20 deg C
These figures include an error of	5 **%**		
Equation Used for Calculation of Voltage Drop Variation with Temperature:		V = I * Rt * Lead Length * 1.05 (error)	
Equation used to Calculate Resistance at temp t		Rt = Ro(1 + alpha*td) td = diff in temp from ref	

Maximum Permissible Voltage Drop For Earth Leads

Lead: 125 sq mm - 500 Amps

Lead Length metres	Table of Lead Voltage Drop vs Temperature of Lead in Degrees Celsius			
	10	20	30	40
4	0.494	0.515	0.535	0.555
4.2	0.519	0.54	0.561	0.582
4.4	0.544	0.566	0.588	0.61
4.6	0.569	0.592	0.615	0.638
4.8	0.593	0.617	0.641	0.666
5	0.618	0.643	0.668	0.693
5.2	0.643	0.669	0.695	0.721
5.4	0.667	0.695	0.722	0.749
5.6	0.692	0.72	0.748	0.776
5.8	0.717	0.746	0.775	0.804
6	0.742	0.772	0.802	0.832
6.2	0.766	0.797	0.829	0.86
6.4	0.791	0.823	0.855	0.887
6.6	0.816	0.849	0.882	0.915
6.8	0.841	0.875	0.909	0.943
7	0.865	0.9	0.935	0.971
7.2	0.89	0.926	0.962	0.998
7.4	0.915	0.952	0.989	1.026
7.6	0.939	0.978	1.016	1.054
7.8	0.964	1.003	1.042	1.082
8	0.989	1.029	1.069	1.109
8.2	1.014	1.055	1.096	1.137
8.4	1.038	1.08	1.123	1.165
8.6	1.063	1.106	1.149	1.192
8.8	1.088	1.132	1.176	1.22
9	1.112	1.158	1.203	1.248
9.2	1.137	1.183	1.23	1.276
9.4	1.162	1.209	1.256	1.303
9.6	1.187	1.235	1.283	1.331
9.8	1.211	1.261	1.31	1.359
10	1.236	1.286	1.336	1.387
10.5	1.298	1.351	1.403	1.456
11	1.36	1.415	1.47	1.525
11.5	1.421	1.479	1.537	1.595
12	1.483	1.544	1.604	1.664
12.5	1.545	1.608	1.671	1.733
13	1.607	1.672	1.737	1.803
13.5	1.669	1.736	1.804	1.872
14	1.731	1.801	1.871	1.941
14.5	1.792	1.865	1.938	2.011
15	1.854	1.929	2.005	2.08
16	1.978	2.058	2.138	2.219
17	2.101	2.187	2.272	2.357
18	2.225	2.315	2.406	2.496
19	2.349	2.444	2.539	2.634
20	2.472	2.573	2.673	
25				
30				

Maximum Output Voltage of AES Portable Earth Tester is Approximately 2.7 Volts

Maximum Resistance of Lead at 20 degrees C	0.245 mohm/m	alpha =	0.0039 for Aluminium
Based on a Full Wave Rectified DC Current of	500 Amps	Ro	0.245 mOhm @ 20 deg C
These figures include an error of	5 %		
Equation Used for Calculation of Voltage Drop Variation with Temperature:		V = I * Rt * Lead Length * 1.05 (error)	
Equation used to Calculate Resistance at temp t		Rt = Ro(1 + alpha*td) td = diff in temp from ref	

Maximum Permissible Voltage Drop For Earth Leads

Lead: 130 sq mm - 500 Amps

Lead Length metres	Table of Lead Voltage Drop vs Temperature of Lead in Degrees Celsius				
	10		20	30	40
		calculated	using ref		
4	0.472	0.492	0.491	0.511	0.53
4.2	0.496	0.516	0.516	0.536	0.556
4.4	0.519	0.541	0.541	0.562	0.583
4.6	0.543	0.566	0.565	0.587	0.609
4.8	0.567	0.59	0.59	0.613	0.636
5	0.59	0.615	0.614	0.638	0.662
5.2	0.614	0.639	0.639	0.664	0.689
5.4	0.638	0.664	0.663	0.689	0.715
5.6	0.661	0.688	0.688	0.715	0.742
5.8	0.685	0.713	0.713	0.74	0.768
6	0.708	0.738	0.737	0.766	0.795
6.2	0.732	0.762	0.762	0.791	0.821
6.4	0.756	0.787	0.786	0.817	0.848
6.6	0.779	0.811	0.811	0.842	0.874
6.8	0.803	0.836	0.835	0.868	0.901
7	0.826	0.861	0.86	0.893	0.927
7.2	0.85	0.885	0.885	0.919	0.954
7.4	0.874	0.91	0.909	0.945	0.98
7.6	0.897	0.934	0.934	0.97	1.006
7.8	0.921	0.959	0.958	0.996	1.033
8	0.944	0.983	0.983	1.021	1.059
8.2	0.968	1.008	1.007	1.047	1.086
8.4	0.992	1.033	1.032	1.072	1.112
8.6	1.015	1.057	1.057	1.098	1.139
8.8	1.039	1.082	1.081	1.123	1.165
9	1.063	1.106	1.106	1.149	1.192
9.2	1.086	1.131	1.13	1.174	1.218
9.4	1.11	1.156	1.155	1.2	1.245
9.6	1.133	1.18	1.179	1.225	1.271
9.8	1.157	1.205	1.204	1.251	1.298
10	1.181	1.229	1.229	1.276	1.324
10.5	1.24	1.291	1.29	1.34	1.391
11	1.299	1.352	1.351	1.404	1.457
11.5	1.358	1.414	1.413	1.468	1.523
12	1.417	1.475	1.474	1.532	1.589
12.5	1.476	1.537	1.536	1.596	1.655
13	1.535	1.598	1.597	1.659	1.722
13.5	1.594	1.66	1.658	1.723	1.788
14	1.653	1.721	1.72	1.787	1.854
14.5	1.712	1.783	1.781	1.851	1.92
15	1.771	1.844	1.843	1.915	1.986
16	1.889	1.967	1.966	2.042	2.119
17	2.007	2.09	2.088	2.17	2.251
18	2.125	2.213	2.211	2.298	2.384
19	2.243	2.336	2.334	2.425	2.516
20	2.361	2.459	2.457	2.553	2.649
25	Maximum Output Voltage of AES Portable Earth Tester is Approximately 2.7 Volts				
30					

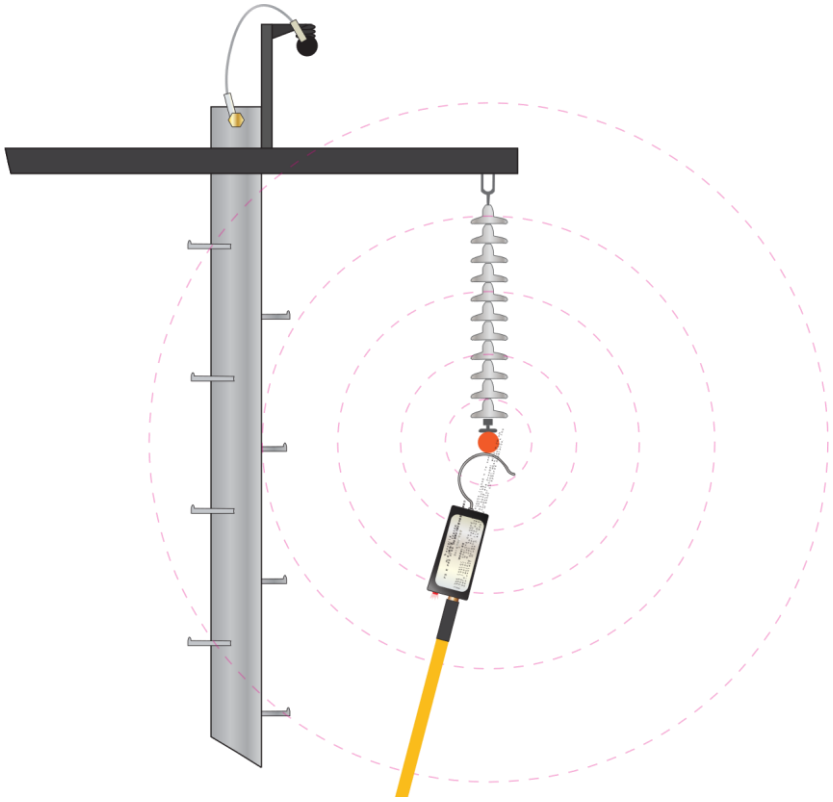
Maximum Resistance of Lead at 20 degrees C	0.234	mohm/m	alpha = 0.0039 for Aluminium
Based on a Full Wave Rectified DC Current of	500	Amps	Ro 0.234 mOhm/m @ 20 deg C
These figures include an error of	5	%	
Approximate Lay Ratio of Cable:	1.133		
Equation Used for Calculation of Voltage Drop Variation with Temperature:			V = I * Rt * Lead Length * 1.05 (error)
Equation used to Calculate Resistance at temp t			Rt = Ro(1 + alpha*td) td = diff in temp from ref

Stranding of Lead	666	0.5 Resistance /metre	rho * I =	0.000207	k (Al)	3.70E+07 S/m @ 20 Deg C
Calculated Area	0.000131		A		Rho (Al)	2.7E-08 Ohm.m @ 20 Deg C
Resistance / m taking into account assumed lay ratio				0.234166	mOhm/metre at 20 Deg C	

Proving Safe to Earth Equipment

Before earthing is applied to any High Voltage (HV) conductors, each conductor of the HV equipment isolated for work must be proven safe to earth (de-energised) at the point where earths are to be applied.

Proving safe to earth equipment consists of a tester, and associated contact pieces or non-contact probes. Testers detect the presence of an alternating electric field surrounding a live electric conductor when the tester is placed within an alternating electric field.



Proving safe to earth is required to ensure it is safe to apply earths. In some situations, it may not be practical to follow this method. In special circumstances the following methods are approved:

- On GIS apparatus, voltage transformers and associated interlocks may be used as the approved method of proving safe to earth;
- If an approved tester is not available at the site or non-functional then permission may be granted by the Controller to use a HV operating rod to carry out an "audible discharge test" to prove conductors de-energised at voltages of 33 kV and above; and
- Where integrated isolating, earthing and short-circuiting equipment is fitted to the outgoing circuit of a HV switchboard and there are no other sources of HV to the circuit.

For easy identification of testers, coloured cases have been provided:

- Black case Universal Testers
- Red case Special testers
- Green case Special non-contact overhead line testers

The following table lists approved proving safe to earth equipment and the situations for its use. When using this equipment, the following conditions must be observed:

- Only the test equipment listed, must be used in each situation; and
- Authorised persons must not use a HV tester unless they are familiar in its use.

Approved equipment for various situations

Situations	Tester		Mode	Contact Piece or Probe	Method of Application	Example Locations
330kV or below AIS Conductors in HV switchyards	Universal Tester	UT	Contact	Hook Contact Piece	Operating Rod	
Through Transparent Panels of Cubicles and HV Cages	Universal Tester		Non-Contact	-	Handheld	Kangaroo Valley PS
At the spouts of Metalclad switchgear	Universal Tester		Non-Contact	Appropriate probe	Handheld	LTSS
Transmission Lines	Universal Tester		Contact	Hook Contact Piece	Operating Rod	
	Special Transmission Line Tester	Green	Non-Contact	-	"Stubby" Operating Rod	Refer: Approved for use on
500kV Conductors in HV switchyards	Special 500kV Tester	Red	Non-Contact	-	Operating Rod	
High 330kV Conductors in HV switchyards	Special 330kV Tester		Non-Contact	-	Operating Rod	
Conductors in Substations with non-standard voltages e.g. 3.3kV	Special Tester		Contact	Hook Contact Piece	Operating Rod	Wallerawang
Inside cabinets containing HV conductors	Special tester		Contact	Special contact probe – nylon rod	Hand held	Mt Piper in 3.3kV cubicles
Gas Insulated Switchgear (GIS)	Special Tester		Non-Contact	Probe built into Switchgear	Coaxial Cable	Beaconsfield West
At the spouts of Metalclad switchgear	Special tester		Non-Contact	Special contact probe	Operating rod	Balranald Murray (Black case)
Voltage Transformers	Two-pole voltage & continuity tester		Contact	-	Hand	LV links

Universal Tester (UT)

The UT is used for most applications involved in contact and non-contact testing. UT's can be used:

- In contact mode at voltage levels from 11 kV up to 330 kV. Switch-selectable ranges of 11-66 kV, 132 kV and 330 kV are provided.
- In non-contact mode. There are two switch-selectable sensitivities; NC1 and NC2. NC1 is the more sensitive.

The UT is used in the majority of proving safe to earth situations and has the following features:

- Front face plate containing a threaded hole with a metal surround (in which to screw an operating rod), an indicating lamp, a test push-button, and a selector switch with positions NC 1, NC2, 11-66 kV, 132 kV, 330 kV and OFF.
- Name plate and instructions on one side and battery case on the other.
- The mounting socket for contact pieces or special non-contact probes is on the end.

Contact Mode

When a UT is to be used for contact mode testing, an operating rod or adaptor piece is screwed into the mounting socket. The operating rod activates a micro-switch which, together with placing the selector switch in either 11-66 kV; 132 kV or 330 kV positions, sets up the tester for contact mode testing. An accessory aluminium hook is then screwed onto the end of the tester. With the operator holding the handle of the operating rod, the hook is brought into contact with a live conductor.

Non-Contact Mode

The UT can be used in non-contact mode with or without special purpose probes to detect live HV conductors without making contact. In non-contact mode, the selector switch should be turned to a non-contact range, NC1 or NC2. NC1 is the more sensitive and should be used at most locations. A UT fitted with a standard non-contact probe is shown below.

Non-contact mode testing is performed with the UT held in the hand and with the range switch selected to either NC1 or NC2. For this mode of testing, nothing must be screwed into the mounting socket and the micro-switch must not be activated.

WARNING: When used for non-contact testing, a UT and its associated special probe care must be taken to ensure that the safe approach distances to exposed HV conductors, as set out in the PSSR, are maintained **except** when testing at approved locations, where approach to the exposed conductors is limited by:

- Clear glass panels without metal reinforcing; or
- Flange on non-contact probe (metalclad switch gear).

Special Testers

Special testers can be either contact mode or non-contact mode devices and have been developed for use in situations which are not covered by the UT. These testers were developed from the UT with modifications to one or more of the following: sensitivity, selector switch, audible indication or micro-switch in operating rod socket.

Special testers have a coloured case to distinguish them from the UT and are clearly marked with the location and type of apparatus for which they are to be used.

Special Testers – Contact Mode

Special contact mode testers and probes have been approved for the following situations:

- HV conductors in substations with non-standard voltages e.g. 3.3kV; and
- Inside cabinets containing HV conductors with non-standard voltages e.g. 3.3kV.

Each contact test probe and tester combination are specifically designed for use at a particular voltage and equipment type and normally have a label clearly indicating the approved locations.

Contact test probes comprise a nylon shaft approx. 20mm in diameter and 720 mm long. A "shield" on the handle of the probe limits the length of shaft inserted into the cabinet and a co-axial cable 1 metre long connects the test probe to the special tester.

These special probes provide a positive method of proving conductors de-energised. Each probe is designed and approved for a specific voltage which is indicated on the probe.

Special Testers - Non-Contact Mode

Special non-contact testers are to be used conjunction with the number of HV operating rod extensions appropriate for the conductor voltage and the appropriate non-contact probe. The same general test procedure is used with this tester as would be used with contact mode testers, except that the tester may only approach the conductors but should not touch them. If the tester does touch the conductor, the tester will not be damaged.

Special Testers – Non-Contact Probes

All non-contact probes are HV tested to 23 kV but the probe must not be allowed to contact the HV conductor being tested.

The flange on the probe is designed to limit amount of penetration of the probe into the switch gear spout. This is for safety and correct functioning of the tester on the particular design of switch gear. Thus, it is important to use only the appropriate non-contact probe which has been approved for the apparatus and will be listed on the probe.

Special Non-Contact Testers for High Conductors in Switchyards

Special non-contact testers for high conductors have the following features:

- A label clearly indicating the approved use.
- Single sensitivity setting and hence no selection switch;
- A threaded socket in which to screw the operating rod. The tester is turned on by screwing the operating rod into the socket;
- An amber indicating lamp and audible buzzer; and
- A test push-button.

When the tester is brought within a particular distance from the live conductor, the electric field will be detected and the indicating lamp will flash.

Special Non-Contact Tester for 500 kV Conductors

All 500 kV non-contact substation testers have the same sensitivity and may be used in any 500kV switchyard.

Special Non-Contact Tester for High 330 kV Conductors

At some locations in 330 kV substations the conductors are situated at a height above ground level which prevents proving these conductors de-energised using conventional HV operating rods and the UT in contact mode. All 330 kV non-contact substation testers have the same sensitivity and may be used in any 330kV switchyard.

Special Non-Contact Tester for Gas Insulated Switchgear

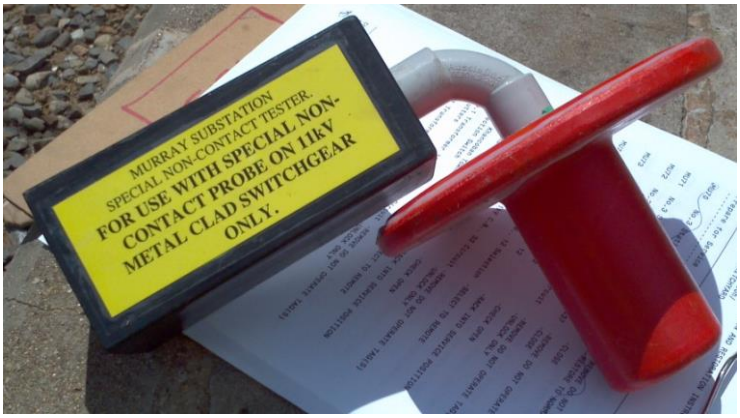
At some sites, GIS earth switches have been provided with a test point to which a special tester may be connected by coaxial cable. This special tester has a selector switch with only two sensitivity settings, NC1 and NC2 (NC1 is the more sensitive).

On the NC1 range, the lamp will flash if the circuit is de-energised on one side of an open isolator but live on the other side of the isolator. If the range switch is changed to the NC2 position, the tester will indicate that the circuit is de-energised. With the tester on the NC2 position, the lamp will flash if the isolator is closed and alive, and hence will correctly indicate whether the conductor being tested is de-energised or alive.

The tester indicates that a conductor is alive by flashing a lamp. These special testers have a label clearly indicating the locations for which it is approved.

Special Non-Contact Tester for Metal clad switchgear

The tester indicates that a conductor is alive by flashing a lamp. These special testers have a label clearly indicating the locations for which it is approved.



Special Non-Contact Tester for Overhead Lines

Non-contact overhead line testers are suitable for use on 500kV, 330kV and 132kV lines. The tester indicates that a conductor is alive by flashing a lamp and sounding a buzzer. The cases of these special testers are coloured green. Overhead line testers have a single sensitivity and are approved for use with “stubby operating rods”.

Only approved for use on:

- 500 kV lines (including 500 kV circuits operating at 330 kV)
- 330 kV double circuit tower lines
- 330 kV double circuit steel pole lines
- 330 kV single circuit delta tower lines
- 220 kV single circuit tower lines
- 132 kV double circuit lines on 330 kV delta towers
- 132 kV single circuit 'n' type wood pole lines

For all other transmission line structures, such as 132 kV steel tower and 132 kV single circuit single pole lines, contact mode testing using a UT must be carried out.

Stubby Operating Rod

The approved stubby operating rod is a T-Mac TMC30.

Two-pole voltage & continuity tester

The Steinel Combi-Check or equivalent is approved for use at the secondary terminals of voltage transformers.

Range AC: 6V to 690V

Proving safe to earth equipment

Equipment Type	Stockcode	Colour	Comments
Universal Tester	003582004	Black	
UT non-contact probe	-	Red	Not stocked
Special Transmission Line Tester	003582079	Green	
Stubby operating rod	003582657	-	T-Mac TMC30
Special Tester - 330kV non-contact	003588274	Red	
Special Tester - 500kV non-contact	003591211	Red	
Special Tester - Non-standard voltages	-	Red	Not stocked
Special Tester - cabinets containing HV conductors	-	Red	Not stocked
Special Tester - (GIS)	-	Red	Not stocked
Special Tester - Metalclad switchgear	-	Red	Not stocked
Two-pole voltage & continuity tester	000333351	-	
Modielive EMF Generator	000362378	-	

Use of HV testers

Checking operation of proving Safe-to-earth equipment

The most thorough method of checking the operation of proving safe to earth equipment is by testing against a known live HV conductor of the same or lower nominal voltage, as it verifies that the electronics of the tester are working and also that the appropriate range has been selected, contact pieces are correctly engaged etc.

Where there is no known live conductor of the appropriate voltage available at the location there are three alternative methods:

- 240V method;
- In-built test button check; and
- Modielive EMF Generator

240V GPO (UT only)

Any 240 Volt GPO which does not have a metal cover plate can be used for this test:

1. Select the NC1 range;
2. Connect the non-contact probe if appropriate; and
3. Place the tester or probe on or near the GPO, the tester lamp should flash.

Inbuilt Test Button

Only permitted using a tester that has been proven against live HV conductors in the previous six months and has a sticker indicating a current test period. Test button checks must be performed with the tester turned ON and any associated equipment attached (operating rod, contact piece, non-contact probe) and the appropriate range selected.

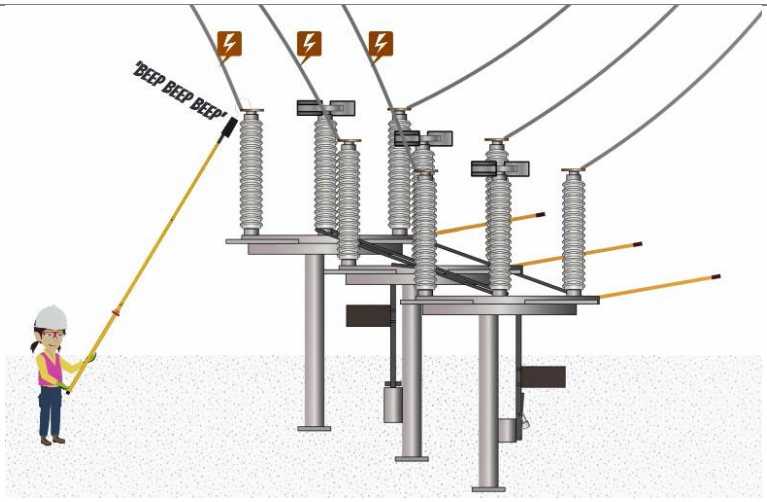
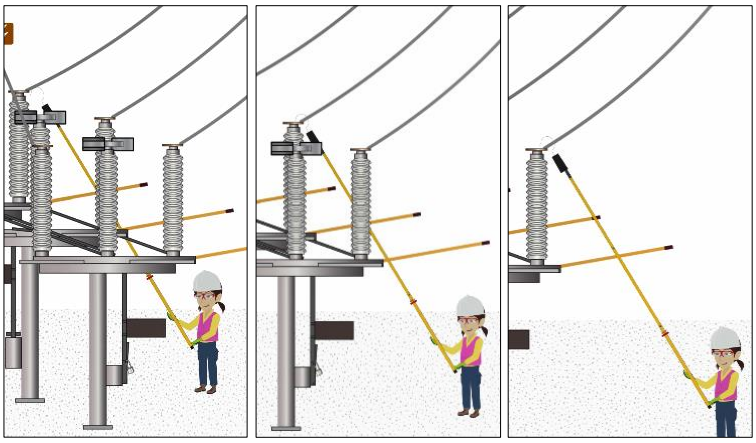
If the lamp flashes when the test push-button is depressed, this proves that the battery is healthy and the circuitry is functioning correctly for the selected range.

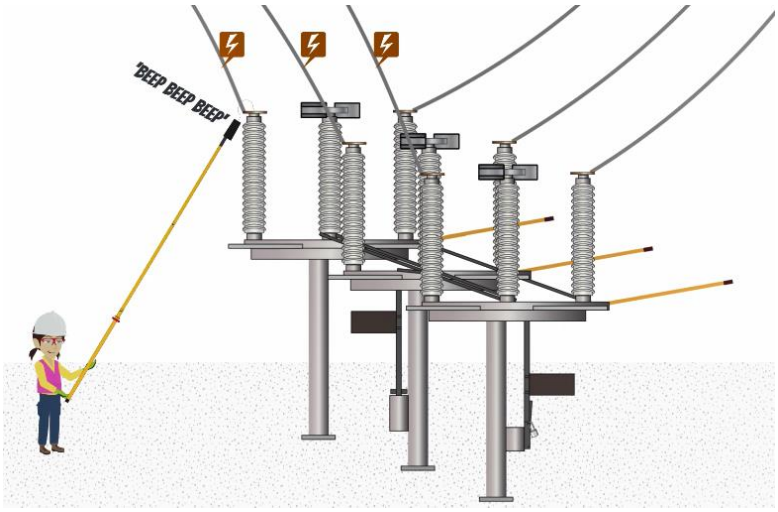
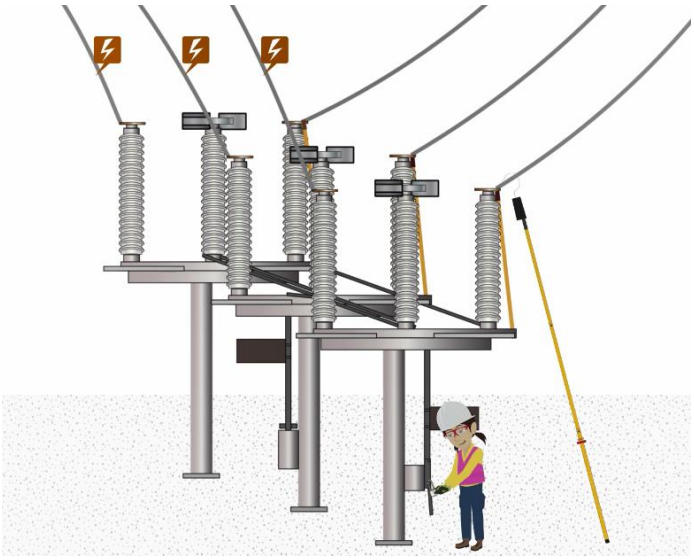
Modielive EMF Generator

1. Holding the HV tester in one hand and the Modielive in the other hand. Face the two units towards each other making sure the Live Area on the Modielive is facing the HV tester.

2. Depress the Modielive ON switch for two or three seconds. The HV tester will indicate a voltage.

General Method of Proving Conductors Safe to Earth

Job Steps	
1. Inspect the HV Tester and any attachments to confirm they are in good condition and within test expiry date. Connect them together and set the HV Tester to the respective voltage.	
2. Check the HV Tester works, by testing on a known live conductor of the same or lower nominal voltage.	
3. Apply the HV Tester to each phase of the point to be proven safe-to-earth. Verify the HV Tester is showing de-energised conductors.	

4. Again, check the HV Tester works, by testing on a known live conductor of the same or lower nominal voltage.	
For a visual reference of conductors that are safe-to-earth, the HV Tester should be hung on the conductor while earthing is applied.	

Audible Discharge Method of Proving Conductors Safe-to-Earth

This method is not approved for voltages below 33 kV.

When using the audible discharge method, the same general method must be followed. The person carrying out the test must hear the discharge when the operating rod is touched on, and withdrawn slightly from, a live conductor.

Maintenance

Testing

- UT's issued for proving HV transmission lines safe-to-earth must on a six monthly basis be checked on a live HV conductor. A sticker must be attached to the case of the tester which records the date when the tester was last proven.
- Other testers do not require periodic testing.

Defective Equipment

When any part of a set of proving safe to earth equipment is found to be faulty (including noticeable change in sensitivity) or fails a test or inspection, it must immediately be withdrawn from use and identified as defective. Faulty items must not be used or re-issued for use until repaired and successfully re-tested.

Maintenance of Equipment

The only field maintenance permitted to be carried out on HV proving safe-to-earth equipment is the changing of batteries. The preferred batteries for HV testers are:

- One 9V transistor battery type PP3 (e.g. Eveready 216)

Care of Equipment

When not in use, all proving safe-to-earth equipment must be switched OFF and adaptor pieces unscrewed and removed. They should be stored and transported in suitable protective cases.

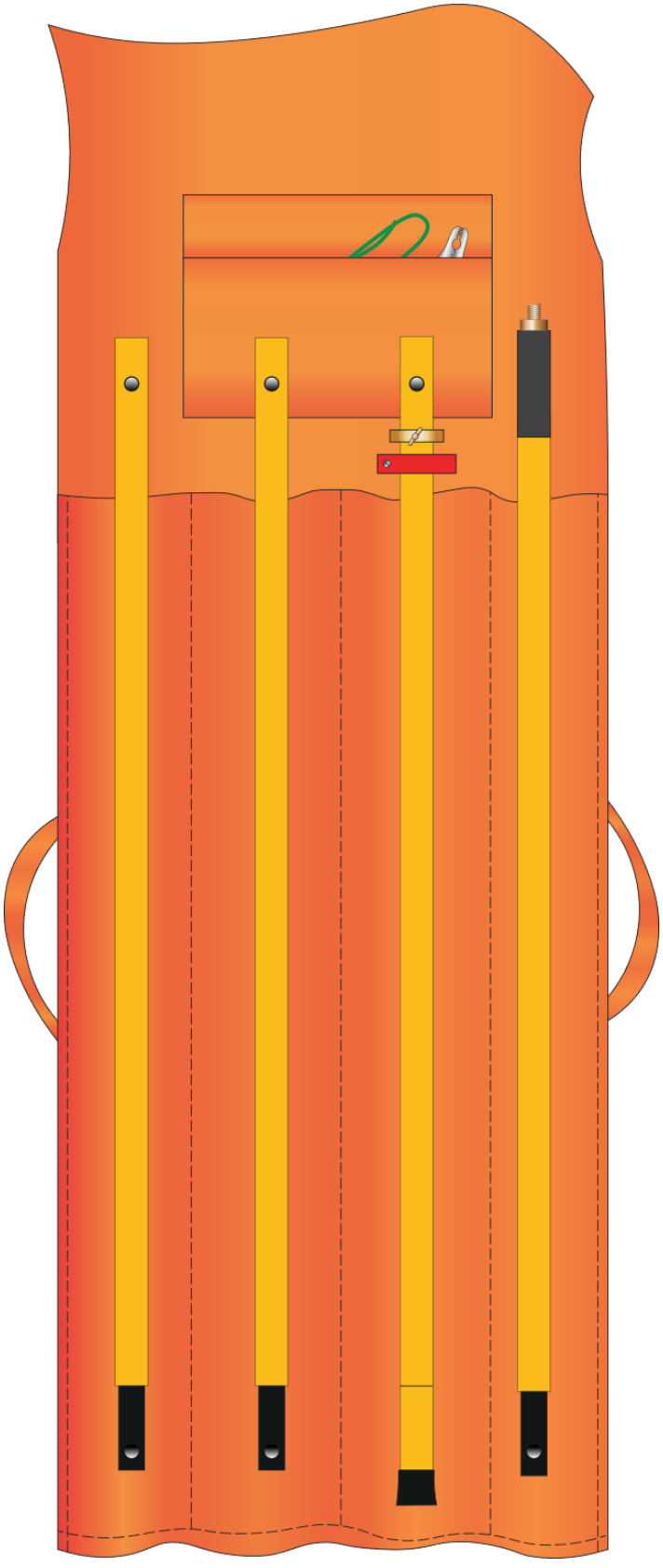
High Voltage Operating Rods

High voltage operating rods have been approved for contact use at a nominal voltage of 330kV or below and for non-contact use up to 500kV.

Approved equipment

Standard HV operating rod set

Comes with four sections of 1.2 metres in effective length and 32 mm in diameter. Each section comprises a fibreglass tube with an injected foam core. The handle is provided with a hand guard which is located 1 metre from the base of the handle. A brass earthing stud is located 50 mm above the hand guard for attachment of the earth lead. Each extension is added by means of a slide fit action and is held securely in place by a spring-operated lock button. The set includes a protective earth lead.



Special operating rod sets

For locations with unusually high busbars, such as power station switchyards, special operating rod sets are available. These special sets consist of a standard handle and head sections with 2 extension sections of 1.6 metres in length. Despite being longer, voltage ratings of special sets are the same as those for the standard HV operating rod.

Safety

When handling HV operating rods:

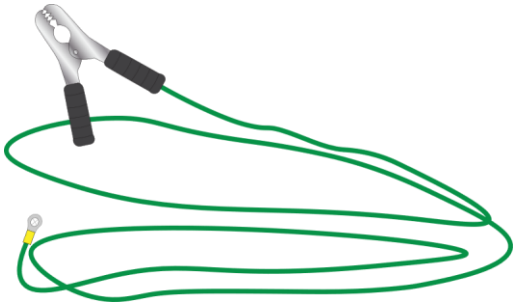
- Assemble, extend or otherwise prepare any operating rods on the ground
- Always carry operating rods below shoulder level
- Maintain SAD when manoeuvring the operating rod past insulator stacks and equipment structures
- Avoid shorting out the effective length of the operating rod to earth or other HV conductors.

For all approved applications the effective length of the operating rod must be appropriate for the nominal voltage of the HV conductors and extra rod sections may be added to reach a link or conductor.

Operation Voltage	Sections	Overall Length
1 kV – 33 kV	2 Handle + one extension	2.5m
66 kV – 132 kV	3 Handle + two extensions	3.7m
220 kV – 330 kV	4 Handle + three extensions	5.0m

Before assembling the handle and the various extension rods, all components must be examined to ensure the rods are clean and that the surface finish is not damaged.

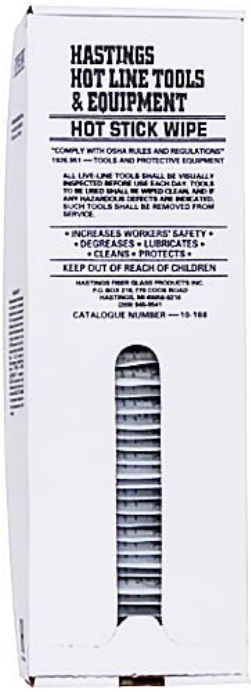
Protective earth lead



When an operating rod is to be used for any purpose on a 330 kV conductor, the earth lead must always be attached to the stud on the hand piece ferrule and the remote end connected to earth. The earth lead must always be used for 330 kV, and in wet weather for 1kV to 220 kV.

Wet weather

Whilst HV operating rods provide adequate insulation levels even in wet weather, to further reduce the surface leakage in conditions of rain, mist or fog, an approved silicone impregnated cloth or water displacing wax should be applied to the length of the rod leaving a water displacing film on the surface.



Approved applications

Situation	Notes
Proving HV conductors safe-to-earth	The proving de-energised tester is attached to the end of the assembled operating rod, the length of the operating rod being appropriate for the voltage of the conductors to be proven safe-to-earth
Earthing	With a link fitting attached to the end of the operating rod, a haulage cord can be fed through an earthing stirrup to apply snap action earthing clamps.
Operating HV links	With a link fitting attached to the end of the operating rod, live operation of link switches, link fuses, etc.
Placement of instruments on or near HV conductors	Instruments such as ammeters may be attached to the end of operating rods and raised onto or near live conductors.
Manipulating contacts of disconnectors and earthing switches	If the contacts of a disconnector or earth switch fail to fully close or open, a HV operating rod may be used to apply pressure to the contact blade to assist the operation.

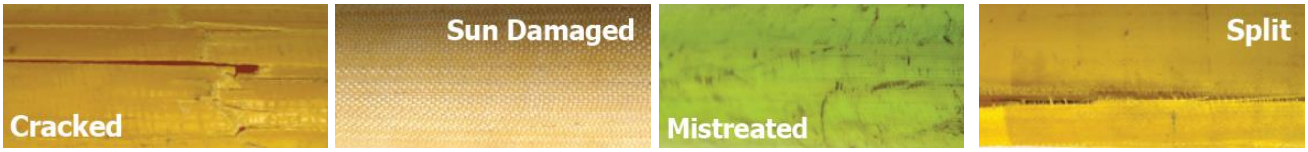
Procurement

HV operating rod equipment is available from Transgrid Store:

Description	Stockcode	UOI
Standard HV operating rod set - TMAC E3212YW	3181377	KIT
Replacement “Head” section 1200mm	3512969	EA
Replacement “Extension” section 1200mm	3512936	EA
Replacement “Special Extension” section 1600mm	3512944	EA
Fibreglass repair kit	3512910	KIT
Link adaptor fitting	3603354	EA
Water displacing wax for fibreglass line sticks	361019	TIN
Cleaning compound for fibreglass line sticks	361020	BOTTLE
Silicone wiping cloth for fibreglass line sticks	361022	PKT (1)
Silicone wiping cloths for fibreglass line sticks	361021	BOX (50)

Maintenance

Before each use, visually inspect the handle and the various extension rods to ensure that the surface finish is not damaged by abrasions, blemishes, cracks and surface deterioration. Any defect within a section of rod is cause for rejection as it may impair the dielectric integrity.



If a section of rod is damaged to the point where the foam core in the centre of the rod could be exposed to moisture, the section is to be destroyed and replaced with a new section which has been HV tested within the previous twelve (12) months.

Spring operated lock buttons and the thread on the head section is to be checked for serviceable operation.

Contaminants such as grease and oil are to be removed with an approved cleaning compound applied with a clean soft cloth or sponge before wiping with a silicone impregnated cloth or water displacing wax over the length of the rod.

Repair

Repairs to the surface coating of operating rods may be made by light sanding and re-coating the approved fibreglass repair kit. Rods which have been repaired must be re-tested before being placed back into service.

Annual testing and recording

At least once per year, each operating rod section must be given a power frequency voltage withstand test of 45 kV per 300 mm of rod for a period of one minute. The test may be applied over either the whole length of the insulating material between the operating head and the hand guard, or individual lengths of 300 mm. The rods are to be tested as a set. The leakage current must be constant and must not exceed 100 micro amps (at 45 kV/300 mm).

An indelible tag must be attached to the handle section. This tag must state the date last tested and the date the set is next due for test.

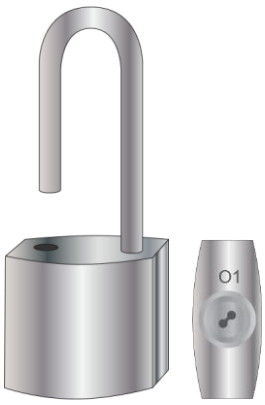
Additional Field Operating equipment

Do Not Operate tag	
Use	-
Limitations of Use	By Authorised persons
Drawing Number	-
Stockcode	0603696
Associated Equipment	-

Warning tag	
Use	-
Limitations of Use	By Authorised persons
Drawing Number	-
Stockcode	0603688
Associated Equipment	-

Switching vest	
Use	Performing Field Operations
Limitations of Use	Field Operation
Drawing Number	-
Stockcode	0360310 (M) 0360311 (L) 0360312 (XL) 0360313 (XXL)
Associated Equipment	-

O1 Lock		
Use	Field Operations, Bridging of Earthing Grid	
Limitations of Use	By Authorised persons	
Drawing Number	-	
Stockcode	20mm shackle, 5mm shaft 50mm shackle, 5mm shaft 25mm shackle, 8mm shaft 50mm shackle, 8mm shaft 25mm shackle, 8mm shaft N/C 50mm shackle, 8mm shaft N/C	3584786 3584794 3584810 3584844 3590700 3590700

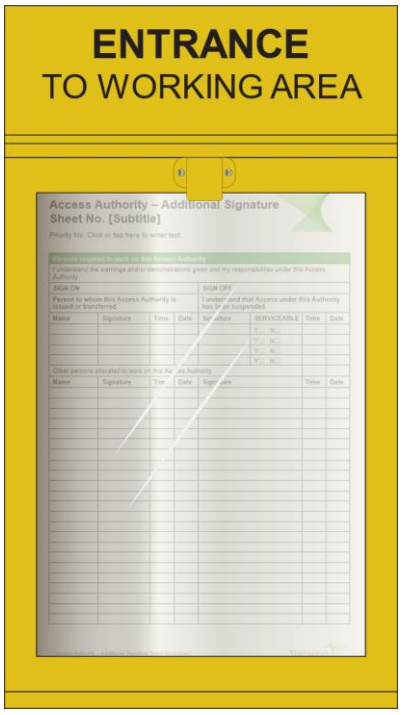


Access Authority equipment

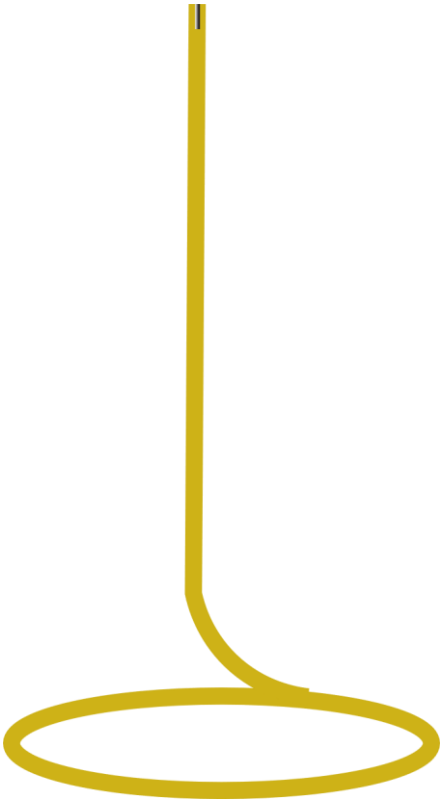
Yellow tape	
Use	HV Access Authority
Limitations of Use	HV Access Authority
Drawing Number	-
Stockcode	003596152
Associated Equipment	Tape reel

Tape reel	
Use	HV Access Authority
Limitations of Use	-
Drawing Number	-
Stockcode	003587003
Associated Equipment	Yellow tape

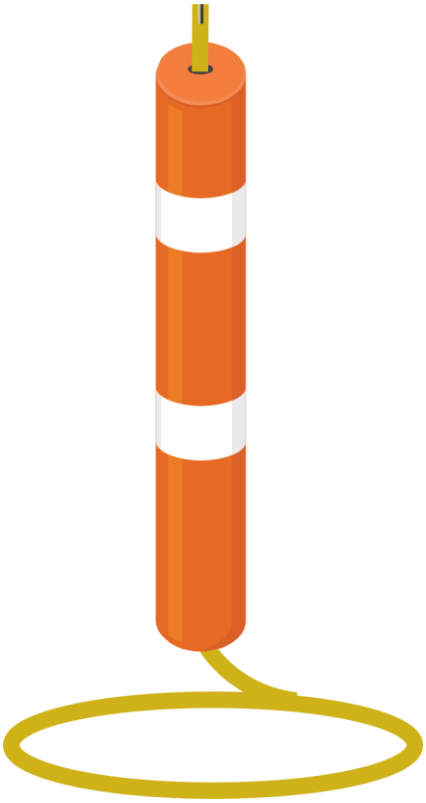
Access Authority holder	
Use	HV Access Authority
Limitations of Use	HV Access Authority
Drawing Number	STD140514
Stockcode	001047323
Associated Equipment	Tape stand



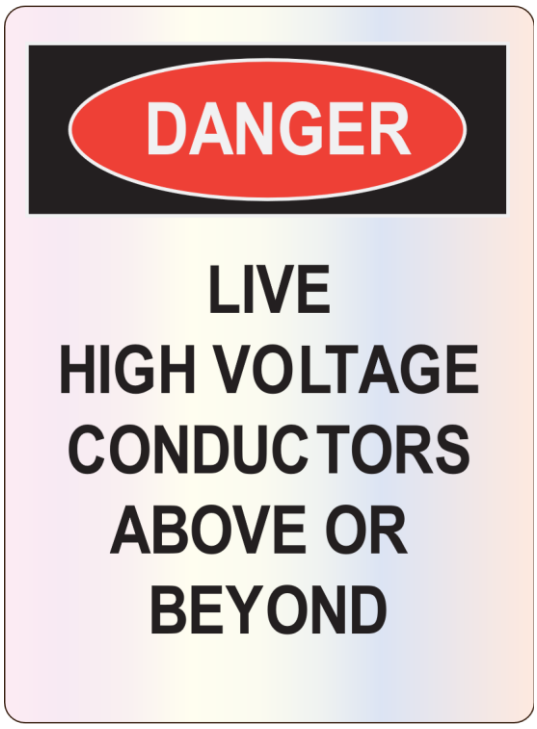
Tape stand	
Use	HV Access Authority
Limitations of Use	HV Access Authority
Drawing Number	STD140516
Stockcode	001047307
Associated Equipment	Yellow tape



DWA Entry bollard kit (4 bollards)	
Use	HV Access Authority
Limitations of Use	HV Access Authority
Drawing Number	-
Stockcode	003598869
Associated Equipment	Tape stand



Sign – Live HV Conductors	
Use	HV Access Authority
Limitations of Use	-
Drawing Number	STD142207
Stockcode	003596848 (sign) 003596806 (bracket)
Associated Equipment	Tape stand



Sign – HV Testing in Progress	
Use	HV Testing Access Authority
Limitations of Use	-
Drawing Number	STD140584
Stockcode	001046952
Associated Equipment	Tape stand

Safety Observer identification

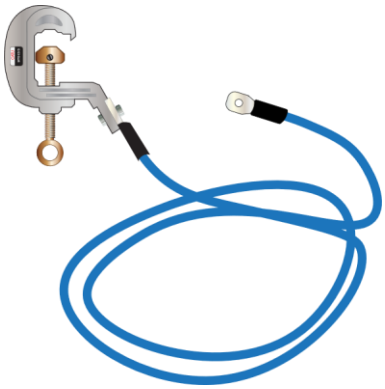
Vest	
Use	Authorised Safety Observer
Limitations of Use	Mobile Plant in the Vicinity of HV
Stockcode	000363278 M 000363279 L 000363280 XL 000363281 XXL
Blackwoods code	02372031 S 02372048 M 02372065 L 02372082 XL 02372099 2XL 02372116 3XL 02372133 4XL 02372150 5XL

Lanyard with whistle	
Use	Authorised Safety Observer
Limitations of Use	Mobile Plant in the Vicinity of HV
Stockcode	000364107
Blackwoods code Min. order 250	03151604

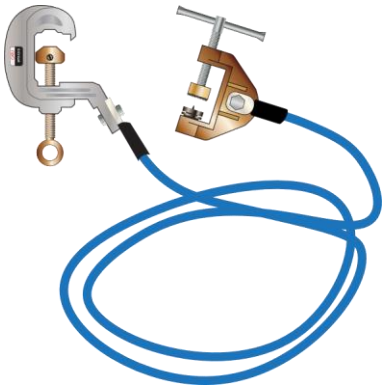
Arm Band	
Use	Authorised Safety Observer
Limitations of Use	Mobile Plant in the Vicinity of HV
Stockcode	000364106

EWP bonding leads

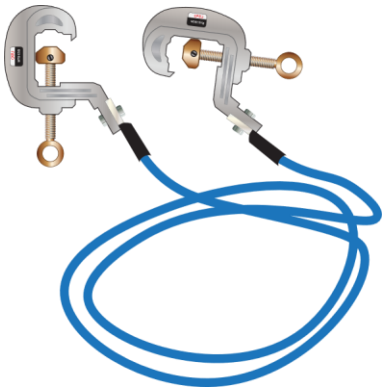
EWP Bond to conductor	
Description	1 x Catu MT-815-S clamp and 1x Lug. Single earth lead, 3m x 35sqmm copper, blue insulation.
Stockcode	363259



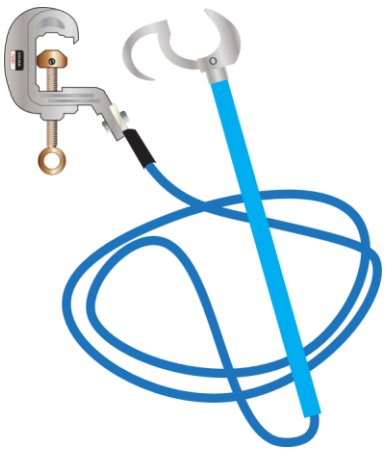
EWP Bond to conductor	
Description	1 x Catu MT-815-S clamp and 1 x Catu MT-847 clamp. Single earth lead, 3m x 35sqmm copper, blue insulation.
Stockcode	363260



EWP Bond to conductor	
Description	2 x Catu MT-815-S shotgun. Single earth lead, 3m x 35sqmm copper, blue insulation.
Stockcode	363261



EWP Bond to conductor	
Description	Transmission Line Quick Release Action Clam. MT-815-S and Quick release Catu Handle. Single earth lead, 3m x 35sqmm copper, blue insulation.
Stockcode	363362



Other leads may be used provided that the following requirements are met:

- Conductor is a minimum size of 35mm2 copper
- Outer insulation colour is not yellow to ensure bond leads are not confused with fault rated earthing leads.
- EWP connections are made using one of the following:
  - A reliable connection such as a permanent connection
  - An earthing stub and Catu MT-815S Clamp
  - A screw action earthing clamp
  - Catu MT-847 paint piercing clamp
- Conductor connections are made using one of the following:
  - Catu MT815S clamp.
  - Catu quick release action clamp and handle for transmission line conductors.

Change from previous revision

Revision no	Approved by	Amendment
0	J McMurtrie, GM/HSE	Replaces: • Proving High Voltage Conductors De-energised • Portable Earthing of High Voltage Conductors • High Voltage Operating Rods
1	J McMurtrie, GM/HSE	Replaces: • Proving High Voltage Conductors De-energised • Portable Earthing of High Voltage Conductors • High Voltage Operating Rods EWP Bonding and Safety Observer equipment added

Transgrid

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as trustee for NSW Electricity Networks Operations Trust (ABN 70 250 995 390).
Registered business name is TransGrid (ABN 70 250 995 390).