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ETS 0020

Amendment No 2 February 2023

Revision History

This specification replaces amendment no 1 of Endeavour Energy Specification ETS 0020. All changes are highlighted in this document with grey colouring.

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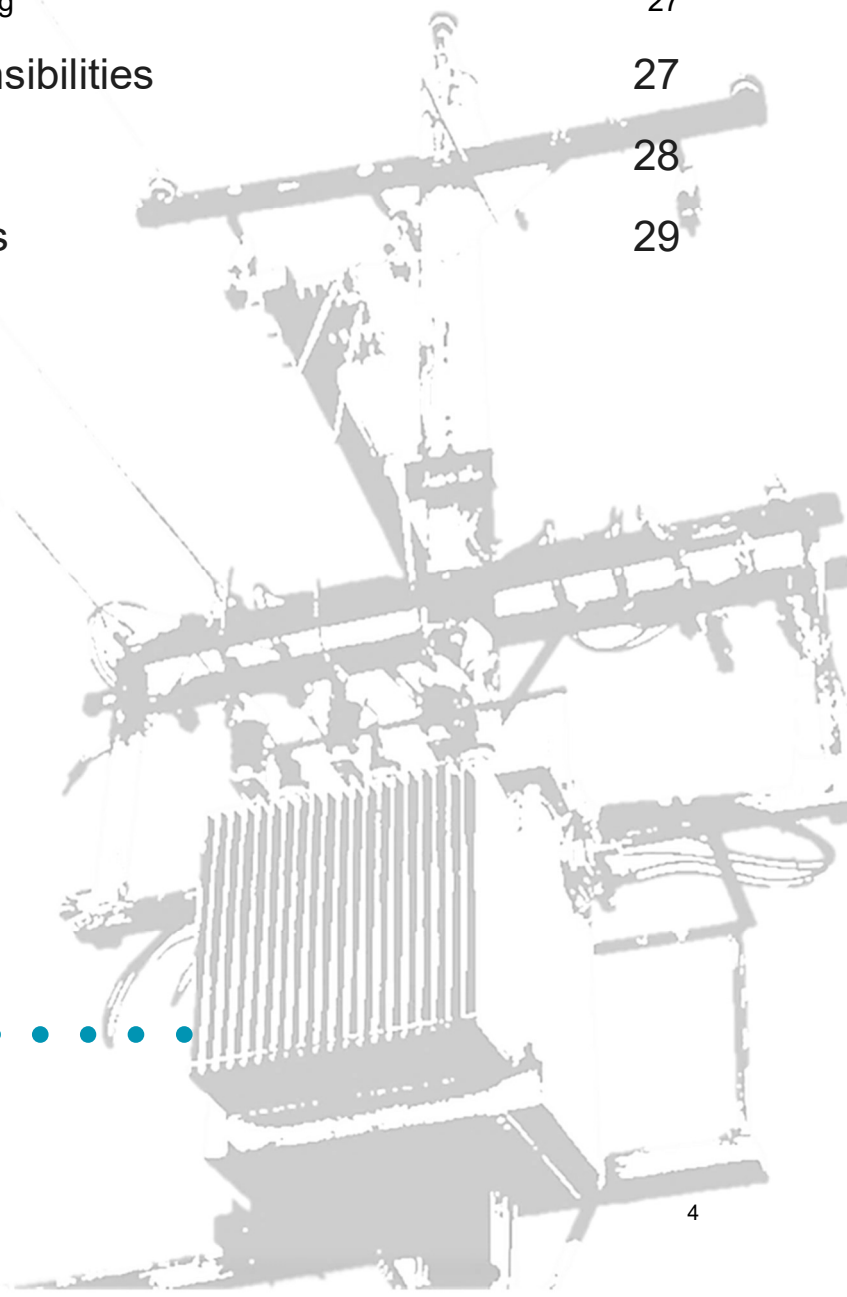
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1 Documentation Scope

This document is to set out in detail the minimum technical requirements for portable earthing for use on Endeavour Energy's transmission and distribution network. Portable earthing equipment includes earthing, short-circuiting, and equipotential bonding equipment.

The specification covers portable earthing equipment listed in Table 1.

This specification does not cover the portable earthing equipment required for any indoor metal-clad switchgear, gas insulated switchgear or any other equipment that may have special termination/connection requirements. These special earthing sets will be sourced directly from the equipment suppliers.

It is not the intention to specify the manufacturing, testing and material requirements in detail. However, the equipment **must** be manufactured to the highest quality standards. The scope includes all items that are specified in this document and other items considered necessary for the safe use of the equipment, whether specified or not.

Equipment offered in response to this specification **must** be manufactured and tested to the standards with the year of publication listed below. Equipment manufactured and tested to previous or later versions of the standards must not be accepted

Where this specification conflicts with a standard, this specification prevails. However, significant inconsistencies must be referred to Endeavour Energy via **Earthing Enquiry** <earthingenquiry@endeavourenergy.com.au> for resolution.

2 References

External Regulations

Electricity Supply Act 1995 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2014

Work Health and Safety Act 2011 NSW

Work Health and Safety Regulation 2017 NSW

External Standards

ENA National Electricity Network Safety Code (ENA DOC 01-2019)

AS 1110:2015 - ISO Metric Hexagon Precision Bolts and Screws

AS 1112:2015 - ISO Metric Hexagon Nuts

AS 1554:2021 - Structural Steel Welding Code

AS 1856:2004 (R2017) - Electroplated Coatings - Silver

AS 3679:2016 -Structural steels, hot rolled bars and sections

External Standards

IEC 61138:2007 - Cables for portable earthing and short-circuiting equipment

IEC 61230:2008 - Portable equipment for earthing or earthing and short circuiting

IEC 60855:2016 - Insulated foam filled tubes and solid rods for live line working

Company Policies and Procedures

Company Policy (Network) 9.2.5 – Network Asset Design

Company Policy 9.2.10 - Network Asset Ratings

Company Policy 9.7.1 - Network Asset Construction

Company Policy 9.8.3 - Network Operations

Company Policy 9.9.1 - Network Asset Maintenance

Company Procedure GSY 1066 - Worksite Hazard and Risk Assessment

Company Electrical Safety Rules

Company Standards

Substation Maintenance Instruction SMI 100 - Minimum requirements for maintenance of transmission and zone substation equipment

SMI 101 - Minimum requirements for maintenance of distribution equipment

Earthing Design Instruction EDI 100 - Distribution earthing design

EDI 516 – Major substation earthing design, construction, and commissioning

3 Definitions and Abbreviations

Term	Definition
LVPPBs	Low Voltage Personnel Protective Bonds
RMS	Root Mean Square
SWER	Single wire earth return
TR	Transmission
UV	Ultraviolet
ZS	Zone Substation

4 Technical Requirements

4.1 Purpose of portable earthing and short-circuiting equipment

The purpose of the portable earthing equipment is to:

- Short circuit and earth de-energized equipment to protect workers from accidental energisation.
- Protect staff working on de-energized and remotely earthed equipment from hazardous voltages due to conductive, inductive or capacitive effects from adjacent energised power lines.
- Provide equipotential safe work area for staff working on equipment as outlined in the company Electrical Safety Rules.
- Provide an equipotential safe area for staff operating HV equipment.
- Enable protection equipment to operate as rapidly as possible and provide maximum protection to staff if electrical equipment at the protected work site is energised inadvertently.
- Protect staff working on de-energized equipment from hazardous voltages due to any inadvertent connection of embedded generation.

4.2 List of earth sets and configuration

A summary of details of portable earthing sets covered in this specification are outlined in Table 1.

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Table 1: Portable earthing and short-circuiting equipment

INTENDED USE	TYPE OF EARTHING SET	GENERIC ITEM DESCRIPTION	SAP STOCK CODE	FAULT RATING kA FOR 0.5Sec
Earthing of outdoor switch yard equipment in zone and transmission substations and switching stations (TR-ZS). This earth set is applied to busbars by the operator standing on ground level.	E1 - A	Portable earth set for transmission and zone substations completed with: 3 x 8.5m phase and 1 x 8m, (*) mm² earth aluminium yellow insulated flexible cable leads 3 x phase clamps suitable for conductor DIA 6-40mm-shotgun spindles 1 x earth clamp suitable for 22mm stub (6-30mm) T bar handle, 1 x insulated junction plate 1 x lifting sling with carabiner assembly Refer to Figure 1	1000005658	24
	E1 - B	Portable earth set for transmission and zone substations completed with: 3 x 6.5m phase and 1x7m, (*) mm² earth aluminium yellow insulated flexible cable leads 3 x phase clamps suitable for conductor DIA 6-40mm-shotgun spindles 1 x earth clamp suitable for 22mm stub (6-30mm)-t bar handle, 1 x insulated junction plate 1 x lifting sling with carabiner assembly Refer to Figure 1	1000006001	24
	E1 - C	portable earth set for transmission and zone substations completed with: 3 x 4.5m phase and 1x6m, (*) mm² earth aluminium yellow insulated flexible cable leads	1000006000	24

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INTENDED USE	TYPE OF EARTHING SET	GENERIC ITEM DESCRIPTION	SAP STOCK CODE	FAULT RATING kA FOR 0.5Sec
		2. 3 x phase clamps suitable for conductor DIA 6-40mm-shotgun spindles, 3. 1 x earth clamp suitable for 22mm stub (6-30mm)-T- bar handle 4. 1 x insulated junction plate 5. 1 x lifting sling with carabiner assembly Refer to Figure 1		
	Operating sticks for E1-2.6m	Operating sticks for TR-ZS 1. 1 x 2.6m insulated shotgun type operating stick Refer to Figure 2	1000005660	N/A
	Operating Sticks for E1-3.2m	Operating sticks for TR-ZS 1. 1 x 3.2m insulated shotgun type operating stick Refer to Figure 2	1000005659	N/A
Transmission and sub-transmission lines on wood/concrete poles (TR-POLE) This earth set is applied to conductors by the operator standing in the bucket of an	E3	Portable earth set for wood, concrete or steel pole transmission lines completed with: 1. 3 x 8m phase and 1x15m (*) mm ² earth copper or aluminium insulated flexible cable leads 2. 3 x phase clamps suitable for conductor DIA 6-40mm- button head spindles 3. 1x earth clamp suitable for earth rod or earth cable DIA 6-30mm T- bar handle, 4. 1 x insulated junction plate 5. 1 x lifting sling with carabiner assembly	1000005921	24

ETS 0020am2– Portable earthing equipment

INTENDED USE	TYPE OF EARTHING SET	GENERIC ITEM DESCRIPTION	SAP STOCK CODE	FAULT RATING kA FOR 0.5Sec
Elevated Work Platform Vehicle.		6. 1 x protective carry bag for above items 1 to 5 7. 3 x 3m f/glass button head splice operating sticks Refer to Figure 1 and Figure 3		
Transmission lines on steel towers (TR-TOWER) This earth set is applied to conductors by the operator standing in the bucket of the Elevated Work Platform Vehicle.	E4	Portable earth set for transmission steel towers completed with: 1 x 8M (*) mm² earth cable copper or aluminium insulated flexible cable lead 1 x phase clamp suitable for conductor DIA 6-40mm- button head spindles 1 x earth clamp piercing suitable for steel structure width 6-40mm T-bar handle, 1 x protective carry bag for above items 1 to 3 1 x 3m f/glass button head splice operating sticks Refer to Figure 3 and Figure 4	1000005922	24
HV Distribution network (HV-POLE) This earth set is applied to conductors by the operator standing on a ladder above crossarm height on the pole.	E5-A	Portable earth set for HV distribution lines completed with: 3 x 3.3m phase and 1 x 13m 35mm² earth, copper insulated flexible cable leads 3 x phase clamp with a beak suitable for conductor DIA 6-40mm- button head spindles. 1 x earth clamp suitable for earth rod or earth cable DIA 6-30mm-T bar handle, 1 x insulated junction plate 1 x lifting sling with carabiner assembly 1 x earth stake 15mm DIAx900mm long - Protective carry bag for above items 1 to 6	1000005253	16

ETS 0020am2– Portable earthing equipment

INTENDED USE	TYPE OF EARTHING SET	GENERIC ITEM DESCRIPTION	SAP STOCK CODE	FAULT RATING kA FOR 0.5Sec
		8. 3 x 1.8m f/glass button head operating sticks (total length 1.8m to suit storage in vehicles). Refer to Figure 1, Figure 3 and Figure 5		
HV Distribution network (HV-SWER POLE) This earth sets is applied to conductors by the operator standing on a ladder above crossarm height on the pole.	E5-B	Portable earth set for HV Single Wire Earth Return (SWER) distribution lines completed with: 1. 1 x 14m 35mm ² copper insulated flexible cable leads 2. 1 x phase clamp with a beak suitable for conductor DIA 6-40mm-button head spindles 3. 1 x earth clamp suitable for earth rod or earth cable DIA 6-30mm-T bar handle 4. Protective carry bag Refer to Figure 4 and Figure 5	1000009300	16
Equipotential bonded work area for HV cable jointing (EQ-BOND)	E6	Fault current bypass assembly completed with: 1. 2 x 3m (*) mm ² copper or aluminium insulated flexible leads 2. 2 x clamps suitable HV cable DIA 25-85mm with insulated handle 3. 1 x brass stub 15mm DIA x 60mm long 4. 1 x protective carry bag for above items Refer to Figure 6(left)	1000006146	24
		Portable equipotential earth mat completed with: 1. 1 x 1.5m 16mm ² flex copper insulated cable lead 2. 1 x earth clamp suitable for earth rod DIA 15mm-insulated handle, 3. 1 x protective carry bag for above items	1000005426	N/A

ETS 0020am2– Portable earthing equipment

INTENDED USE	TYPE OF EARTHING SET	GENERIC ITEM DESCRIPTION	SAP STOCK CODE	FAULT RATING kA FOR 0.5Sec
		Refer to Figure 6(right)		
Trail earth set for Live Line (TRAIL-6)	E7	Portable trailing earth set completed with: 1 x 6m (*) mm² copper or aluminium insulated flexible lead 2 x clamps ball-pin suitable for steel structure or conductor DIA 6-40mm T-bar handle, 1 x protective carry bag for above items Refer to Figure 7	1000005573	24
Trail earth set for moving plants inside substation (TRAIL-25)	E8	Portable trailing earth set completed with: 1 x 25m (*) mm² copper or aluminium insulated flexible lead 1 x phase clamp piercing/ball-pin suitable for steel structure width 6-40mm T-bar handle, 1 x earth clamp suitable for 22mm stub (6-30mm)-t bar handle 1 x protective carry bag for above items Refer to Figure 7	1000006773	24
LV Personnel Protective Bonds (LVPPB)	E9 - A	LVPPB for overhead earth set completed with: 4 x pole clamps-spring tensioned suitable for conductor DIA 6-20mm with insulated handle 1 x 2.1m +2x 0.95m 50mm² flexible copper orange insulated flexible cable leads 1 x protective carry bag for above items Refer to Figure 8	1000006061	16

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INTENDED USE	TYPE OF EARTHING SET	GENERIC ITEM DESCRIPTION	SAP STOCK CODE	FAULT RATING kA FOR 0.5Sec
	E9 – B	LVPPB for underground cable pillar earth set completed with: 1. 4 x 0.5m 50mm² flexible copper orange insulated flexible cable leads 2. 1 x cable lead connected to terminal block on one end and the other end with strands contained in copper sleeve/end connector 3. 1 x protective carry bag for above items Refer to Figure 8	N/A	24
Earth grid bridging earth set (BR-E)	E10	Earth grid bridging earth set completed with: 1. 1 x 2m (*) mm² flexible copper or aluminium insulated lead 2. 2 x earth clamp suitable for cylindrical conductor DIA 6-20mm with insulated handle, 3. 1 x protective carry bag for above items Refer to Figure 7	1000006772	24
Pipe bridging earth set (PIPE-E)	E11	Pipe bridging earth set completed with: 1. 1 x 8m (*) mm² flexible copper or aluminium insulated lead 2. 2 x phase clamp suitable for cylindrical pipe DIA 20-120mm with insulated handle, 3. 1 x protective carry bag for above items Refer to Figure 6(left) and Figure 7	1000006792	24

(*) Cross-sectional area of the conductor must be determined by the manufacturer.

5 General requirements

5.1 General

The earthing and short-circuiting equipment, as specified under this specification, **must** be delivered as fully assembled. The manufacturer **must** provide details of the recommended operating and maintenance procedures along with each item.

5.2 Summary of technical requirements

All portable earthing equipment specified **must** comply with following standards:

- IEC 61138: - Cables for portable earthing and short-circuiting equipment
- IEC 61230: - Portable equipment for earthing or earthing and short circuiting
- IEC 60855: - Insulated foam filled tubes and solid rods for live line working

5.3 Service conditions

The equipment must be suitable for use in a temperature range of –10 deg C to +55 deg C, in a dusty and moist environment, and for 'normal use' as specified in IEC 61230. All ratings and equipment performance must be guaranteed for this environment.

5.4 Environment

The equipment must normally be used in an outdoor location. It may be used at certain sites/locations affected by heavy industrial pollution and coastal salt contamination.

The equipment must be designed to withstand harsh and corrosive environmental conditions and to deliver satisfactory service despite repeated use.

Ferrous parts are to be hot dip galvanised. If hot dip galvanising interferes with the intended performance of the ferrous parts, a covering with a suitable anticorrosive paint is required.

The manufacturer must provide full details of the surface finish provided. All component and parts supplied must be tested in accordance with section 7.

All insulation material used must be UV stabilised.

All equipment must be designed so that there is no safety hazard to operating personnel.

5.5 Weight of the earthing set

The weight of the components of the earthing set **must be considered** to ensure that the effort required to apply them to conductors is within the capability of operators and aligned with the requirements of NSW WHS legislation. The highest possible temperature rise for the conductor must be adopted to reduce the weight. A suitable safety margin **must** be maintained in selecting components.

Different configurations of earth sets may be considered where they can be shown to reduce the lifting weight of the set to reduce risk of injury.

Operator standing position at the time of applying portable earths must be considered as some earths are applied on pole top positions (e.g., E5 earth sets) or from Elevated Work Platforms (e.g., E3 earth sets). Consideration must be given to the use of mechanical aids to assist lifting.

5.6 Performance

The performance of equipment, devices and components must be in accordance with IEC 61230, IEC 60855 and IEC 61138 as applicable. The withstand capability of the devices and equipment must be expressed by their rated values of fault current and duration. As cables are exclusively intended for earthing and short-circuiting no voltage is specified (Ref section 1 of IEC 61138).

5.7 Mechanical stress during faults

All metallic components of the earthing equipment, such as cables, lugs, clamps and junction plates, are subject to very high mechanical loads during fault conditions. This situation is aggravated when long lengths of cables are left mechanically unsecured.

As outlined in IEC 61230 it is the responsibility of the user (operator) to consider movement of connecting cables due to magnetic forces prior to making a final connection. Also touching a device shortly after short circuit can result in personal injury. The devices must be removed from service after exposure to short circuit current. The manufacturer's operating and maintenance procedure for the equipment will need to include these concerns (Ref 4.10 of IEC 61230).

5.8 Electrical stress during faults

Electrical and magnetic stress, and in turn the thermal stress, must be considered very carefully in the design. Adequate measures must be taken to minimise the potential hazards due to these effects.

Adiabatic methods must be used in calculating the current and thermal ratings of the metallic components of the equipment.

The short circuit rating given in this document is only the system **R.M.S** fault current that could be expected in different location/voltages of the network.

5.9 Flexibility

The earthing set must be able to be stored in a manner that minimises the space requirements for transportation. The manufacturer must show that the conductor material is highly flexible to satisfy this requirement.

5.10 Ratings

All components of the portable earthing equipment specified under this specification **must** be suitable to withstand fault ratings specified in Table 1.

Testing must be carried out using a test current 15% higher than the rated current (Refer 5.7.4.1 of IEC 61230). Peak current factor 2.5 times as stated in section 5.7.4.2 of IEC 61230 is applicable. A test time of 1.15 times the rated time as stated in section 5.7.4.3 of IEC 61230 is applicable. Applicable test value tolerance as stated in section 5.7.4.5 of IEC 61230 is applicable.

The earthing system of Endeavour Energy is mainly solid earthed and hence earthing cables used must have same cross-section area as the associated short-circuiting cables (Ref 4.3.2 of IEC 61230). The connection to the temporary earth rod installation is used only when permanent earthing is unavailable.

Endeavour Energy transmission voltages are 132kV, 66kV and 33kV. Distribution voltages are 22kV, 11kV, 12.7KV (SWER) and 400V.

Note to Endeavour Energy Operators:

Near some Bulk Supply Points, fault currents can be as high as 40kA. Requirements of portable earthing and short-circuiting equipment at such locations are to be met by using two (2) sets of earthing equipment in parallel.

5.11 Concept diagrams of portable earthing equipment

The diagrams related to portable earthing equipment stated in Table 1 are provided in Figure 1 to Figure 9.

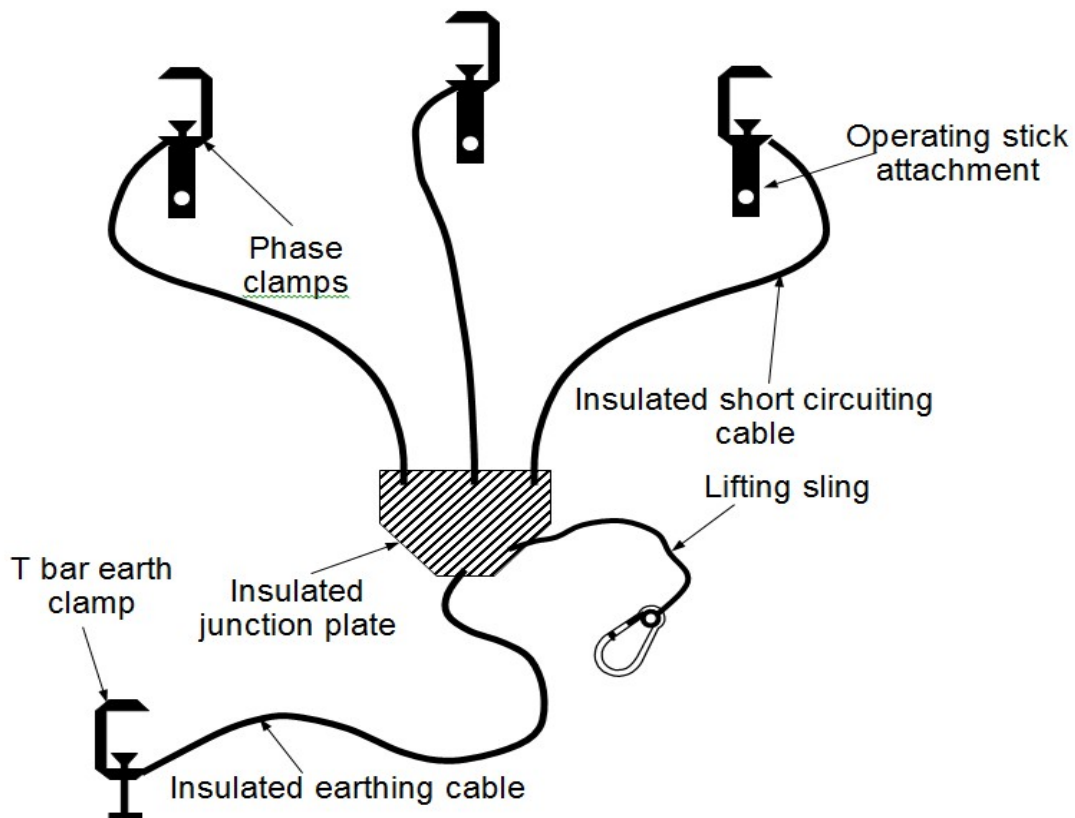


Figure 1: Conceptual sketch of E1, E3 and E5-A portable earth sets Refer Table 1 for all inclusions



Figure 2: Typical shotgun operating handle for use in transmission and zone substations



Figure 3: Typical button head operating handle use for transmission and HV distribution lines

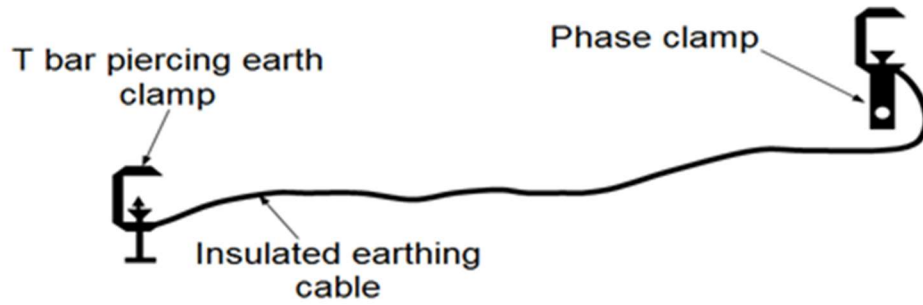


Figure 4: Conceptual sketch of E4 steel tower portable earth sets -Refer Table 1 for all inclusions

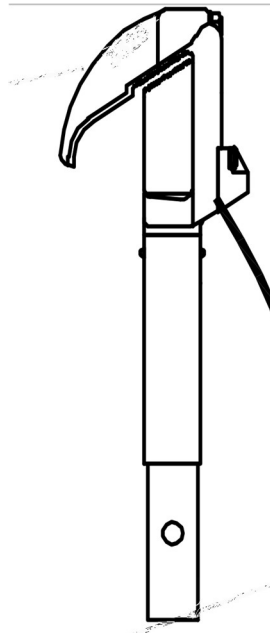


Figure 5: Phase Clamp with a beak for item E5-A and E5-B

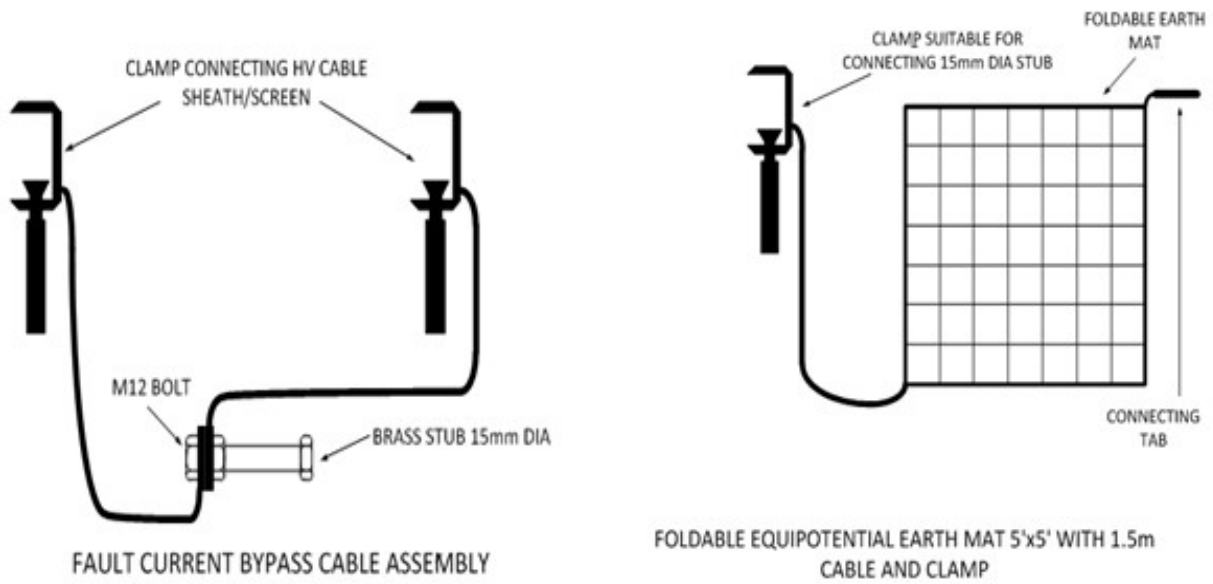


Figure 6: Conceptual sketch of E6 for fault current bypass cables and foldable equipotential earth mat for HV cable jointing -Refer Table 1 for all inclusions.

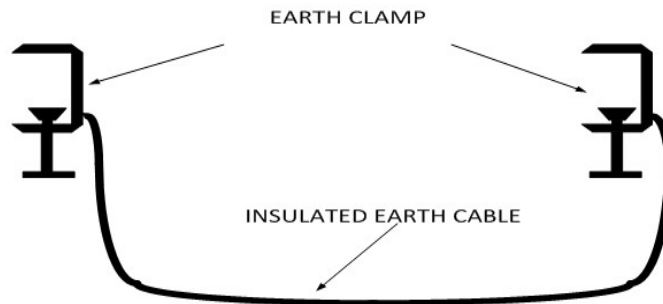


Figure 7: Conceptual sketch of E7 / E8 Trailing cable lead and E10/E11 bridging earth leads -Refer Table 1 all inclusions

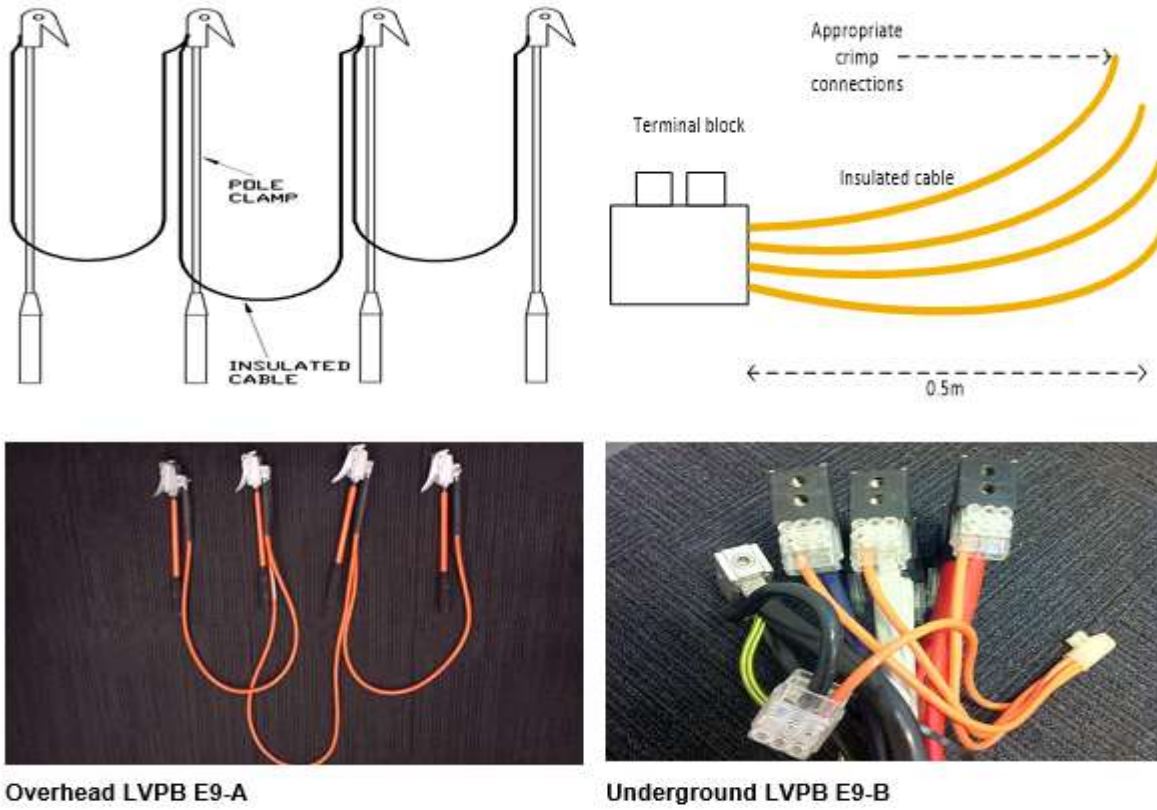


Figure 8: Concept sketch and example of E9 for Personal Protection Bonds for LV -Refer Table 1 for all inclusions

6 Specification for individual components

6.1 Phase clamps normal

Phase clamps (Line clamps as described in IEC 61230) must provide reliable contact performance and be suitable for clamping on high voltage and low voltage overhead conductors as applicable. The clamp jaw opening must be adjustable and must be suitable for clamping on conductors with diameter from 6 mm to 40 mm. Clamps for fault current bypass cables (E6 earthing set) must be suitable for clamping HV underground cables with diameter from 25mm to 85mm. Clamps for pipe bypass cables (E11 earthing set) must be suitable for clamping pipes with diameter from 20mm to 120mm.

Snap-on type clamps may be considered for the E3 earth sets provided it demonstrates that it has better operator usability over conventional screw type phase clamps.

The clamp jaws must be designed to prevent slippage and to allow for fast attaching to phase conductors. Their mechanical strength must be suitable for intended use and sufficient to withstand the forces developed during the flow of fault current.

Clamps must be suitable for attaching the specified type of operating sticks as stated in Table 1.

The following durable marking on clamp itself must be provided as specified in 4.9.3 of IEC 61230:

- Manufacturer's name or trademark
- Model or type reference for clamp

6.2 Phase clamps with a beak

Phase clamps (Line clamps as described in IEC 61230) must provide reliable contact performance and be suitable for clamping on high voltage overhead conductors. The earth sets completed with these phase clamps are applied to overhead conductors by an operator standing on a ladder. For the operator to catch the conductors easily whilst standing on a ladder, the phase clamp must be provided with a beak. Refer to Figure 5. The clamp jaw opening must be adjustable and must be suitable for clamping on conductors with diameter from 6mm to 40mm.

The clamp jaws must be designed to prevent slippage. Their mechanical strength must be suitable for intended use and sufficient to withstand the forces developed during the flow of fault current.

Clamps must be suitable for attaching button head type of operating sticks as stated in Figure 3.

The following durable marking on clamp itself must be provided as specified in 4.9.3 of IEC 61230:

- Manufacturer's name or trademark
- Model or type reference for clamp

6.3 Earth clamp

Earth clamp must be securely attached to the earth cable of the earth set. The earth clamps must provide reliable contact performance.

The clamp jaw opening must be adjustable and must be suitable for clamping on earth connection points as specified in Table 1.

The clamp's mechanical strength must be suitable for intended use and sufficient to withstand the forces produce by fault current.

The clamp must be provided with a type of handle as specified in Table 1.

The following durable marking on clamp itself must be provided as specified in 4.9.3 of IEC 61230:

- Manufacturer's name or trademark
- Model or type reference for clamp

6.4 Pole clamps for overhead LVPPBs

Pole clamps (Line clamps as described in IEC 61230) specified for E9-A earth set must be spring loaded or screw type for firm contact with cylindrical conductors with diameters from 6 mm to 20 mm. Length of the insulated pole clamp handle must be in the range of 300mm to 700mm. The pole clamp must be provided with a grip handle. Fault rating of the pole clamp must be greater than the fault rating of the connecting cable leads.

The following durable marking on each clamp must be provided as specified in 4.9.3 of IEC 61230:

- Manufacturer's name or trademark
- Model or type reference for clamp

6.5 Earthing cables

The earthing cables must be manufactured and tested in accordance with IEC 61138 Standards.

6.5.1 Earthing Cable General

If the conductor size is not specified in Table 1, the size is to be determined by the manufacturer based on the stated fault duration and rating. It is preferable to use the nominal cable sizes stated in IEC 61138, however cables with sizes other than those stated in IEC 61138 may be used subjected to approval from Endeavour Energy.

The insulation covering must also be capable of protecting the cable from mechanical and chemical damage.

Conductor material, colour of insulation and length of cable leads for different earthing sets are outlined in Table 1.

Thickness of the insulation, maximum diameter of wire strands must comply with the values outlined in Table 2. The data for the Table 2 is extracted from Table 3 and Table 4 of IEC 61138.

Table 2: Data specification for earthing cables extracted from IEC 61138

Nominal Cross-sectional Area of conductor	Maximum diameter of wires in conductor	Thickness of insulation Normal specified value		Mean overall diameter				
		EPR and PVC	SiR	Lower limit		Upper limit		
				EPR and PVC	SiR	EPR	PVC	SiR
mm ²	mm	mm	mm	mm	mm	mm	mm	mm
16-Copper	0.21	1.2	1.4	7.1	7.5	8.9	8.6	9.5
50-Copper	0.31	1.5	1.6	11.7	11.9	14.6	14.2	15.2
70-Copper	0.31	1.8	2.1	13.4	14.6	16.8	16.2	17.4
95-Copper	0.31	1.8	2.3	15.5	16.5	19.3	18.7	19.9
150-Aluminium*	0.46	1.8	2.8	18.6	20.6	23.3	22.5	24.0

*Maximum conductor resistance at 20 deg C for 150 mm² Al cable is 0.208 Ω/km. Derived values for maximum conductor resistance for outside the nominal sizes of Al cables are applicable.

6.5.2 Marking of earthing cables

The following durable legible marking must be made by printing or embossing on insulation of the cable at an interval not exceeding 550mm as a minimum specified in IEC 61138 and IEC 61230:

- Cable manufacturer's name or trademark
- Cross sectional area of the conductor "...mm²"
- Nature of insulation covering (ref clause 7 of IEC 61138)

6.6 Operating stick

Operating sticks are required for operating the phase clamp to grip phase conductors. The head of the operating stick must be provided with shotgun or button head type adapter to match with the phase clamp specified in Table 1.

The shotgun operating stick will allow for separation of the stick from the phase clamp by using a control finger. The Shotgun type operating sticks are selected for transmission and zone substation switch yards as they can be conveniently disconnected leaving the earth clamps connected to the earthing system.

The button head type sticks are selected for transmission and distribution line earthing (E3, E4 and E5 earthing sets) as these earths are left connected with the operating stick hanging until the works are completed.

The operating sticks must be manufactured and tested in accordance with IEC60855 Standards.

Each operating stick must be marked with the following minimum information as specified in 4.5 of IEC 60855-1:

- Name or trademark of the manufacturer
- Outer diameter
- Date of manufacture (month and year) and serial number unique for each stick
- Manufactured and tested in accordance with IEC 60855.

The sticks must be free of cracks, surface damage or any mechanical defects.

The operating stick lengths, types and number of operating sticks in each earth set are given in Table 1.

6.7 Cable lugs

Cable lugs must be used for terminating all earthing cables. Cable lugs must be of a type that minimises conductor bending at and around the lug mouth to minimise metal fatigue damage to the conductor.

On each cable end, a UV stabilised transparent (clear) mastic lined thick-walled heat shrink tube must be applied to **overlap with** the cable and lug. The heat shrink must be a minimum of 100mm long for cables sized 16mm² and a minimum of 200mm long for cables sized above 16mm². This tubing or approved equivalent must prevent water ingress into the cable, support the cable and minimise bending at the lug mouth to reduce the fatigue damage. Transparent heat shrink tubing is **required** to provide inspection of cable ends for fatigue damage before it is being used.

A common failure mode for LVPPBs (set E9-A) is mechanical wear and tear where the cable attaches to the clamp. Additional support, such as that provided by heat shrink or cable ties, may be required for cable lugs used for LVPPBs to prevent cable ends moving relative to the handle/clamp and loosening nuts attaching the cable lugs to the clamps. Suitable lock nuts must also be used for attaching cable lugs to the clamps. The manufacturer must demonstrate how they have addressed this common failure mode.

6.8 Insulated short circuiting junction plate

An insulated short circuiting junction plate is required for E1-A, E1-B, E1-C, E3 and E5-A earthing sets to provide for the following connections:

- Three (3) connection points for three of phase conductors.

- One (1) connection point for the earth conductor.
- One (1) connection point for lifting sling

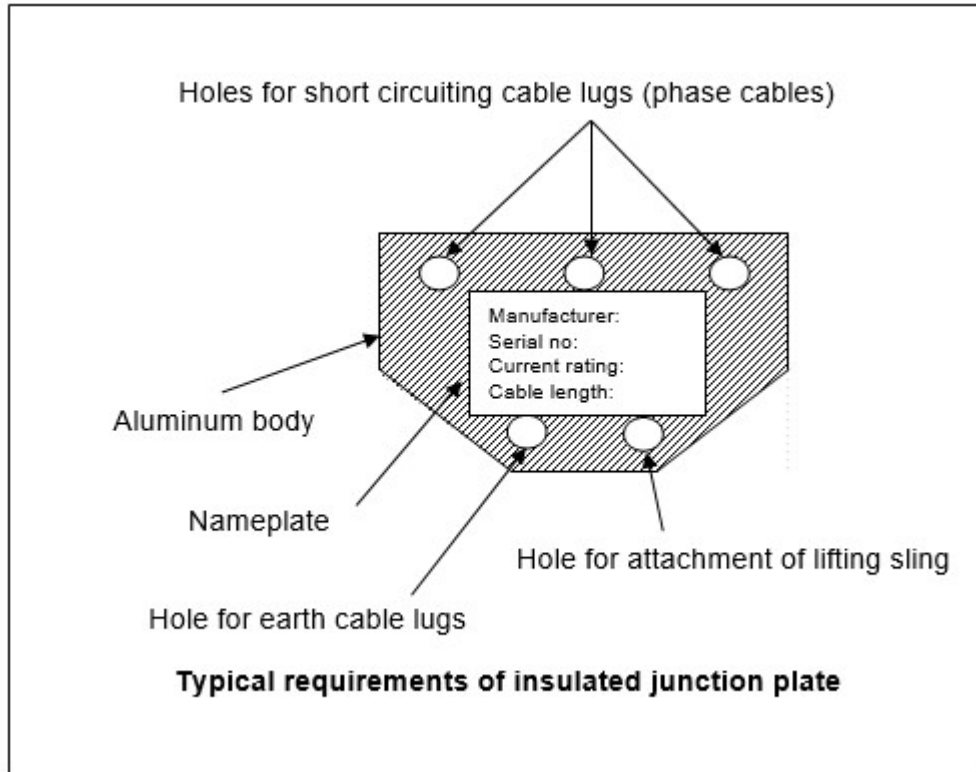


Figure 9: Insulated Junction Plate concept diagram

The junction plate must be designed to withstand short circuit rating stated in Table 1. The junction plate, as well as other metallic parts attaching to the plate, must be insulated.

A name plate specified in section 6.11 must be attached to the junction plate.

Alternative configurations for the E3 and E5 sets without a junction plate may be considered where a more efficient application is proposed that minimises operator exposure to excessive weight.

6.9 Lifting Sling

The lifting sling must be non-conductive and have adequate strength to support the weight of the equipment and withstand short circuit forces inflicted on it when the phase and earth conductors pass fault current. The sling must be a minimum of 1m long, completed with a carabiner hook approximately 10mm x 100mm.

6.10 Earth stake

An earth stake is required as part of the E4 earthing set to provide a firm connection to earth. Earth stake installation is used when permanent earthing facility is not available.

The earth stake must have the following specifications.

- Diameter - 15mm
- Length - 900mm
- Construction Copper clad mild steel or electroplated copper on mild steel (minimum thickness 250 μm)

6.11 Nameplate

Metal or durable plastic name plate with following minimum information must be stuck or screwed to the junction plate. For portable earth sets where there is no junction plate, a name plate tag must be stuck to a cable lead near the earth clamp.

The information can be stamped, engraved, or embossed on the name plate. The information is required to be legible and remain legible even after repeated use.

- Manufacturer's name or trademark.
- Manufacturer's model or type and serial number (unique for each earth set).
- Year of manufacture (Month and Year)
- Rated fault current and duration.
- Manufactured in accordance with IEC 61230.
- Cable length (phase conductor length/earth conductor length).
- Type of earthing set (Refer to Table 1)
- Intended use (Refer abbreviation in Table 1)

6.12 Foldable equipotential earth mat

Foldable earth mats **must** be made with durable vinyl/polymer fabric or other insulating material. Tinned copper braids in a grid pattern **must** be permanently stitched to the mat to provide an equipotential zone. The mat must be furnished with a permanently connected 1.5m long flexible copper insulated cable of minimum 16mm² and a clamp suitable to connect to a 15mm diameter earth rod or a brass stub. The mat must be provided with a 15mm diameter connecting tab to enable the jointing of two or more mats together. Mats are to be approximately 1.3m x 1.3m in size and the weight including cable and clamp and carry bag must not exceed 20kg. The mat must be easily foldable and stored in a carry bag. Operation, testing and maintenance instructions must be provided with each earth mat.

6.13 Protective carry bag

The earthing sets which are required to be supplied in protective carry bags are specified in Table 1. The protective carry bag must be made from durable material such as vinyl/ polymer and be able to be carried to the worksite comfortably.

Durable marking is required on the protective carry bag for identification of type of the earth set and the weight.

The following information is required to be printed on one side of the bag

- Type of the earthing set (e.g., E10)
- Gross weight including earthing set (e.g., 19kg)
- Endeavour Energy

7 Tests and inspection

7.1 Accreditation and acceptability of testing authorities

All tests must be carried out by a testing authority holding appropriate accreditation:

- by the National Association of Testing Authorities, Australia (NATA); or,
- by an accredited authority recognised by NATA Australia.

All type test reports must be accompanied by copies of the accreditation certificate/s issued to the testing laboratory. The accreditation certificate/s must be valid for the relevant test/s and for the duration of the test/s.

Tests from other testing authorities, such as KEMA, may be accepted at the discretion of Endeavour Energy.

7.2 Type tests

The equipment must be type-tested in accordance with the requirements of IEC 61230, IEC 61138 and IEC 60855. The type tests stated in Annexure A must be conducted on portable earthing equipment as a minimum.

7.3 Sampling tests

The sampling tests stated in Annexure A must be conducted on the equipment in accordance with IEC 61230, IEC 61138 and IEC 60855.

8 Product approval

All portable earthing for which approval is sought must comply with this Specification and all applicants (suppliers/manufacturers) seeking approval must comply with Endeavour Energy's product approval process. The documentation and samples required for the approval must be provided by the supplier. If the required conditions are satisfied, a product approval number for each product will be issued by Endeavour Energy.

8.1 Documentation required for product approval

The applicant (supplier/maker) who requests the approval of portable earthing equipment must provide the following PDF documentation to Earthing Enquiry earthingenquiry@endeavourenergy.com.au with the application.

- completed product approval and audit form FAE3212.
- copies of accreditation certificate/s issued to the testing laboratory to cover all type tests.
- copies of test report for all sample and routine tests listed in Annexure A
- a written confirmation from the cable manufacturer that the product complies with this specification.
- a drawing showing assembly of all components and name plate details.
- operating and maintenance instructions

8.2 Sample/s of portable earthing

Sample/s of portable earthing must be submitted along with product approval form.

9 Authorities and Responsibilities

Manufacturers/suppliers must be responsible for:

- Being aware of their responsibilities under this instruction.
- Provided suitable training for their staff/contractors.
- Implementing this instruction and keeping Endeavour Energy or other responsible equivalent officers informed of any factors that may prevent them from accepting responsibility for its full implementation.
- Ensuring that an effective quality auditing system is in place.
- Providing test reports and other documents to **Earthing Enquiry**
<earthingenquiry@endeavourenergy.com.au>

Chief Asset and Operations Officer has the authority and responsibility for:

- Approving technical specifications including any variations.
- Making all decisions concerning compliance in respect to this Specification.
- Approving nominations of Endeavour Energy representatives.
- Delegating any of these authorities and responsibilities to the Manager Design.

Manager Design has the authority and responsibility for:

- Reviewing technical specifications and making recommendations to the Chief Asset and Operations Officer.
- Making recommendations concerning compliance in respect to this Specification.

Design Manager Mains has the authority and responsibility for:

- Reviewing technical specifications and making recommendations to the Manager Design.
- Making recommendations concerning compliance in respect to this Specification.

Design Delivery Manager Electrical has the authority and responsibility for:

- Reviewing all test reports submitted and making recommendations to the Design Manager Mains.
- Ensuring that the content of this specification kept up to date

Manager Supply Chain must be responsible for:

- Determining quantities and purchasing equipment to comply with this ETS.

The Transmission Managers/Distribution Managers/Operators must be responsible for:

- Ensuring that the new and replaced portable earthing equipment complies with this ETS.
- Inspection of the equipment and checking the validity of the test information prior to use.
- Following the operating maintenance procedures supplied by the manufacturer.

10 Document Control

Documentation content coordinator: Design Delivery Manager Electrical

Documentation process coordinator: Branch Process Coordinator

Annexure A: Specified Tests

Table 3: Type tests for portable earthing set complete assembly

Test reference	Test name	Test results/criteria
IEC 61230 Section 5.4.1	Fatigue test on cable with end fittings	-No cracks or wrinkles are observed on the cable insulation -No more than 1% of the conductor strands are broken
IEC 61230 Section 5.4.2	Humidity penetration test on cable with end fittings.	-Copper conductor does not turn black -Aluminium conductor does not turn brown
IEC 61230 Section 5.5	Tension test cables with end fittings	-No connection has loosened
IEC 61230 Section 5.6	Test on clamps	-No damage such as cracks or deformation is seen on the clamp during visual verification after test
IEC 61230 Section 5.7	Short-circuit current test for one set	-There is no current interruption during the test time -The values of peak current, Joule integral, test time and rms current measured are all in accordance with those prescribe in section 5.7.4 of IEC61230
IEC 61230 Section 5.7	Short-circuit current test for 2 sets in parallel	-There is no current interruption during the test time -The values of peak current, Joule integral, test time and rms current measured are all in accordance with those prescribed in section 5.7.4 of IEC21230
IEC 61230 Section 5.8	Durability of marking	The marking remains legible and the letters do not smear.

Table 4: Sampling tests for portable earthing set complete assembly

Test reference	Test name	Test description/criteria
IEC 61230 Section 5.4.1	Fatigue test on cable with end fittings	-No cracks or wrinkles are observed on the cable insulation -No more than 1% of the conductor strands are broken
IEC 61230 Section 5.4.2	Humidity penetration test on cable with end fittings.	-Copper conductor must not turn black -Aluminium conductor must not turn brown
IEC 61230 Section 5.5	Tension test cables with end fittings	-No connection has loosened
IEC 61230 Section 5.8	Durability of marking	The marking remains legible, and the letters do not smear.

Table 5: Type test for operating earth sticks

Test reference	Test name	Test description/criteria
IEC 60855 Section 5.3.3	Dimensional check	To the tolerance in Table 1 of IEC 60855
IEC 60855 Section 5.5.6	Durability of marking.	The markings are still legible, and the characters do not run or smear.
IEC 60855 Section 5.3.2	Visual check	-There are no visual defects

Test reference	Test name	Test description/criteria
IEC 60855 Section 5.4.3	Dielectric test after exposure to water	Test results to section 5.4.2.1.5 -The current does not exceed the value provided in Table 2 of IEC 60855 -The phase angle above 80 deg. During the test, there is no sign of flashover or puncture of any of the test pieces.
IEC 60855 Section 5.4.3	Wet test	Test results to section 5.4.3.1.3 -No flashover during the test -No spark over or puncture -No visual sign of tracking or erosion on the surface -No temperature rise greater than 7 deg. C
IEC 60855 Section 5.5.1	Bending test	-To the values given in Table 3 of IEC 60855.
IEC 60855 Section 5.5.2	Torsion test	-No sign of failure
IEC 60855 Section 5.5.4.1	Bending ageing test	-After 4000 cycles, the test piece shows no signs of deterioration.
IEC 60855 Section 5.5.4.2	Dielectric test after mechanical ageing	-The current does not exceed the value provided in Table 2 of IEC 60855 -The phase angle over 50 deg. -During the test, there is no sign of flashover or puncture of any of the test pieces.
IEC 60855 Section 5.5.5	Dye penetration test	-No sign of solution dye penetration.

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Table 6: Sampling tests for operating earth sticks

Test reference	Test name	Test description/criteria
IEC 60855 Section 5.5.1	Bending test	-To the values given in Table 3 of IEC 60855.
IEC 60855 Section 5.5.2	Torsion test	-No sign of failure.

Table 7: Type Tests on earthing cables used for portable earthing

Test reference	Test name	Test description/criteria
IEC 601138 Section 5.1.2	Voltage test immersed in water	-Withstand 1kV for 5 mins with no damage to insulation.
IEC 601138 Section 5.1.3	Spark test	-No sign of failure
IEC 601138 Section 5.2	Overall diameter test	-Mean overall diameter must be within the limits specified in Table 3 and 4 of IEC 61138. -Ovality must not exceed 15%
IEC 601138 Section 5.3	Flexibility test	-Pass the test -Cu conductors-I' values < in Table 2 of IEC61138 -Al conductors- on cracks to insulation after testing and electrical resistance variation <10%.

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