AUSTRALIAN CONSTRUCTORS ASSOCIATION

Construction & Building Industry Safety Guideline

Overhead Power Line Earthing

Disclaimer

This Guideline contains information regarding work health and safety. It includes some of your obligations under the work health and safety and electrical safety legislation that jurisdictional regulators administer. To ensure you comply with your legal obligations you must refer to the appropriate Acts and Regulations that apply in the jurisdiction where you are conducting your work.

This publication may refer to legislation that has been amended or repealed. When reading this Guideline you should always refer to the latest jurisdictional laws. It is the responsibility of the businesses and the individuals involved to ensure that a safe system of work is employed and that statutory requirements are met.

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Construction & Building Industry Safety Guideline

Overhead Power Line Earthing

Intent

The intent of this guideline is to protect persons and equipment from hazardous voltages by establishing a systematic and safe method of maintaining non-hazardous voltage levels on transmission and distribution lines to prevent the potential of induced voltage and transferred earth potentials.

Scope

This guideline applies to overhead transmission and distribution lines that are under construction or maintenance and have no physical connection to a source of electrical supply.

Dangerous voltages can occur on transmission and distribution lines by the following circumstances:

- Line voltage,
- Electromagnetic induction,
- Electrostatic induction,
- Lighting,
- Transfer voltages,
- Voltage gradients,
- Line energising and,
- Neutral and earthing gradients.

Safety Imperatives

a. Every electrical conductor must be treated as 'live' until it has been tested, proved de-energised and earthed.

b. All workers involved with Overhead Power Line Earthing are to be deemed competent to perform their assigned tasks.

c. An assessment must be carried out at the workplace to assess all risks and dangerous voltages that might have the potential to cause harm or damage.

d. Permit systems shall be developed and implemented where and as required.

e. Workers must maintain the applicable 'safe approach distance' to all conductors known or assumed to be live.

f. All test and safety equipment shall be inspected prior to use to ensure so far as is reasonably practicable that it is in a safe condition and fit for purpose.

g. Equipment used to earth overhead conductors must be rated to sustain a fault current consistent with the nominal line voltage and any likely fault current.

h. Defective tools and equipment must be immediately removed from service, tagged and placed in a quarantine area.

i. A documented systematic approach shall be used for the building and construction work, including the application and removal of earths with each step of the process adhered to in the correct order.

P = Primary responsibility **S = Support role / Involved**

Overhead Power Line Earthing - Guideline

Imperative Item.	Safety Imperative	Element Guidance	Element Timing	Project Manager	Construction Manager	Project/Site Engineer	Safety Professional	Supervisor	Leading hand	Workers	Expected Outcome	Standard, Regulation Reference
a.	Every electrical conductor, including earth conductors must be treated as 'live' until it has been tested, proved de-energised and earthed.	• All electrical equipment and conductors shall be regarded as energised until isolated and proved de-energised. • Work shall not be carried out on or near de-energised exposed conductors until an electrical worker has: a) Positively identified the electrical equipment, all of its energy sources and their isolation points. b) Isolated and discharged where necessary the electrical equipment and current from all sources of supply. c) Secured the isolation. d) Proved de-energisation of all electrical equipment and conductors. e) Identified the safe area of work. • Any voltage tests used to prove de-energization shall be conducted in the following sequence: a) Test the voltage tester on a known voltage source for correct operation. b) Test between all conductors and a known earth. c) Test between all conductors. d) Retest the voltage tester on a known voltage source for correct operation. • Only competent persons shall perform the tests. **Refer to the ACA Guideline on Electrical Isolations and Appendices A and B for further guidance.**	Prior to work commencing on site and during the life of the work process.	S	S	S	S	P	S	P	Every electrical conductor has been tested, proved de-energised and earthed.	WHS Act & Regulations or jurisdictional equivalent (Vic & WA) Refer Table 1 Energy Networks Association Doc 001 – National Electricity Network Safety Code Safe Work Australia - General Guide : Working in vicinity of electric lines Local Electricity Supply Authority Electrical Safety Rules
b.	All workers involved with Overhead Line Earthing are to be deemed competent to perform their assigned tasks.	• Copies of all employees and contractors licenses and certificates of competency to be reviewed prior to commencement of work.	Prior to work commencing on site and during the life of the work process.	P	S	S	S	S	S	P	Competent people undertaking the work to plan and expected outcomes achieved.	WHS Act & Regulations or jurisdictional equivalent (Vic &

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Overhead Power Line Earthing - Guideline

Imperative Item.	Safety Imperative	Element Guidance	Element Timing	Project Manager	Construction Manager	Project/Site Engineer	Safety Professional	Supervisor	Leading hand	Workers	Expected Outcome	Standard, Regulation Reference
		• Above records maintained for review as required by client and external inspectors • All persons working on site are to be site and project inducted to ensure they understand site and job requirements. • If personnel are temporarily or permanently physically or mentally impaired, e.g. under the influence of alcohol, drugs, fatigue or are injured to a level that adversely affects their work performance, they shall not undertake work. **Refer to Appendices A and B for further guidance**										WA) Refer Table 1
c.	An assessment shall be carried out at the worksite to assess all risks and dangerous voltages that might have the potential to cause harm or damage.	• All workers involved in the task shall be consulted and participate in the risk identification and assessment process. • Project hazard register and safe work method statements populated with all identified hazards, risk assessments and control measures • Dial before dig complete at the sites • Site hazard analysis, crane pad and lay down areas identified prior to work commencing **Refer to Appendices A and B for further guidance**	Prior to work commencing on site and during the life of the work process.	S	S	S	S	P	S	P	Hazards identified and risks are sufficiently eliminated or controlled to enable the work to be done safely.	WHS Regulations 34-38 or jurisdictional equivalent (Vic & WA) Refer Table 1 Safe Work Australia - General Guide : Working in vicinity of electric lines
d.	Permit systems shall be developed and implemented where and as required.	• Where required access permits must be in place prior to commencing works. • A work permit system should be considered for any work being performed on or near electrical equipment where potential hazards of injury to personnel or equipment damage exist.	Prior to work commencing on site and during the life of the work process.	S	S	S	S	P	S	P	Potential hazards of injury to personnel or equipment damage are managed appropriately.	WHS Act & Regulations or jurisdictional equivalent (Vic & WA) Refer Table 1

P = Primary responsibility **S = Support role / Involved**

Overhead Power Line Earthing - Guideline

Imperative Item.	Safety Imperative	Element Guidance	Element Timing	Project Manager	Construction Manager	Project/Site Engineer	Safety Professional	Supervisor	Leading hand	Workers	Expected Outcome	Standard, Regulation Reference
		• The work permit system should set out relevant conditions of accessing electrical equipment, supervision of work, electrical and or mechanical isolation of equipment, use of safety observers, use of safety equipment, safe approach distances, conditions of restoring operational status and other relevant matters. NOTE: Permit systems may require practices additional to the requirements set out in this Guideline. **Refer to Appendices A and B for further guidance**										
e.	Workers must maintain the applicable 'safe approach distance' to all conductors known or assumed to be live.	• Qualified spotters/observers shall be in place for work in proximity of live overhead lines • If a safety observer is deemed necessary, the safety observer shall be competent in relevant rescue procedures. **Refer to the ACA Guideline on Prevention of Overhead Power Line Strike, and Appendices A and B for further guidance.**	Prior to work commencing on site and during the life of the work process.	S	S	S	S	P	S	P	Potential hazards of injury to personnel or equipment damage are managed appropriately.	WHS Act & Regulations or jurisdictional equivalent (Vic & WA) Refer Table 1 Safe Work Australia - General Guide : Working in vicinity of electric lines
f.	All test and safety equipment shall be inspected prior to use to ensure that it is in a safe condition and fit for purpose	• Test instruments shall be fit for purpose, within calibration and of the correct category for the application. • Insulated tools and equipment shall be of an approved type and shall be in good order,	Prior to use and during the life of the work process.	S	S	S	S	P	S		Correct tools and equipment used and in good order	WHS Act & Regulations or jurisdictional equivalent (Vic & WA)

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Overhead Power Line Earthing - Guideline

Imperative Item.	Safety Imperative	Element Guidance	Element Timing	Project Manager	Construction Manager	Project/Site Engineer	Safety Professional	Supervisor	Leading hand	Workers	Expected Outcome	Standard, Regulation Reference
		regularly maintained and tested. • Tools and equipment check sheet in place and completed • Approved safety harness and other necessary safety equipment and PPE shall be used where appropriate.										Refer Table 1
g.	Equipment used to earth overhead conductors must be rated to sustain a fault current consistent with the nominal line voltage and any likely fault current	• Earth leads to be attached and in place prior to any work being undertaken and in the correct location • Earthing equipment to be put in place by competent and trained persons in accordance with the work instructions and guidance note • Work to be conducted in the safe zone **Refer to Appendices A and B for further guidance**	Prior to work commencing on site and during the life of the work process.	S	S	S	S	P	S	P	Correct equipment used and consistent with the nominal line voltage and any likely fault current.	WHS Act & Regulations or jurisdictional equivalent (Vic & WA) Refer Table 1
h.	Defective tools and equipment must be immediately removed from service, tagged and placed in a quarantine area.	• All defective tools and equipment shall be tagged out of service and removed from site as they are identified. **Refer to Appendices A and B for further guidance**	Prior to work commencing on site and during the life of the work process.	S	S	S	S	P	S	P		WHS Act & Regulations or jurisdictional equivalent (Vic & WA) Refer Table 1
i.	A systematic approach shall be used for the application and removal of earths with each step of the process adhered to and documented.	• Where the work risk assessment identifies the need for bonding, the conductors shall be bonded together and connected to the general mass of earth at the work site. • Bonding to earth may be affected by connecting conductors to the earthing system with	Prior to work commencing on site and during the life of the work process.	S	S	S	S	P	S	P		WHS Act & Regulations or jurisdictional equivalent (Vic & WA) Refer Table 1

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Overhead Power Line Earthing - Guideline

Imperative Item.	Safety Imperative	Element Guidance	Element Timing	Project Manager	Construction Manager	Project/Site Engineer	Safety Professional	Supervisor	Leading hand	Workers	Expected Outcome	Standard, Regulation Reference
		conductors that are adequate to carry the potential short circuit currents to the electrical installation earthing system. • The cross-section area of the conductor shall not be less than 4mm. • Temporary bonding conductors shall always be connected together and attached to the general mass of earth prior to any attempt is made to attach them to any de-energised component of the electrical installation. • Suitable PPE should be used when attaching or removing temporary bonding conductors. **Refer to Appendices A and B for further guidance**										

Key references applicable to this Safety Guideline are:

Safe Work Australia - Code of practice: Construction Work
Safe Work Australia – General Guide: Working in the vicinity of overhead and underground electric lines
Energy Networks Association Doc 001 – National Electricity Network Safety Code
Local Electricity Supply Authority - Electrical Safety Rules

Australian / New Standards

AS/NZS 7000 Overhead Line Design – Detailed Procedures (previously ENA C(b)1 Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines)

American Standards / References

ASTM-F2249: Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-Energized Electric Power Lines and Equipment
ASTM-F855: Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-Energised Electric Power Lines and Equipment
Institute of Electrical & Electronics Engineers (IEEE 524): Guide to the Installation of Overhead Transmission Line Conductors

Table 1 - Legislative Summary

Jurisdiction	Legislation
Commonwealth	Work Health and Safety Act, 2011 Work Health and Safety Regulations, 2011
Australian Capital Territory	Work Health and Safety Act, 2011 Work Health and Safety Regulations, 2011
New South Wales	Work Health and Safety Act, 2011 Work Health and Safety Regulations, 2011
Northern Territory	Work Health and Safety (National Uniform Legislation) Act, 2011 Work Health and Safety (National Uniform Legislation) Regulations, 2011
Queensland	Work Health and Safety Act, 2011 Work Health and Safety Regulations, 2011 Electricity Safety Regulations, 2013
South Australia	Work Health and Safety Act, 2012 Work Health and Safety Regulations, 2012
Tasmania	Work Health and Safety Act, 2012 Work Health and Safety Regulations, 2012
Victoria	Occupational Health and Safety Regulation, 2007 **Note:** WHS Regulations not yet introduced in this jurisdiction.
Western Australia	Occupational Health and Safety Regulation, 1996 **Note:** WHS Regulations not yet introduced in this jurisdiction.

Table 2: Regulatory Guide – Particular requirements that may be relevant to overhead power line earthing. Note: This is not a complete list of all regulations that may be applicable for the work. Reference must be made to the relevant Work Health and Safety Regulation or jurisdictional equivalent OHS Regulation for a complete list of regulatory requirements.	
Work Health and Safety Regulation	**Subject area**
Regulation 32	Application of Part 3.1
Regulation 33	Specific requirements must be complied with
Regulation 34	Duty to identify hazards
Regulation 35	Managing risks to health and safety
Regulation 36	Hierarchy of control measures
Regulation 37	Maintenance of control measures
Regulation 38	Review of control measures
Regulation 39	Provision of information, training and instruction
Regulation 44	Provision and use of personal protective equipment
Regulation 147	Electrical safety – Risk management

Appendix A. Hazards which Exist

Broadly, there are three main hazards associated with work involving overhead line earthing. They are:

- Induced voltages on the conductors of the line being constructed.
- Voltages developed by faults on an adjacent circuit across the ground directly adjacent to a tower known as “step potential”, and to a tower “touch potential”. The term “potential” here simply means voltage.
- Working in proximity to live circuits under a single circuit outage condition, double circuit lines.

1. Induced Voltage

With voltages, electrostatically and electromagnetically induced from adjacent circuits operating under normal conditions.

2. Step and Touch Potential

“Step” and “Touch” potentials are produced when conductors are connected at the tower, for example, when terminating or when clamping in and a fault occurs on an adjacent line causing a high voltage to be induced in the conductors being strung.

The discharge current from this induced voltage can cause a potential drop to be developed for the duration of the fault (not more than one (1) second) across the ground directly adjacent to the tower. This is also the reason for attaching all equipment at the tensioner to the earth grid. Anything within the grid area is safe but step voltage can occur at the grid perimeter. This is the reason for fencing the area and limiting access to defined positions.

3. Lightning

a. The Project Manager or delegate shall manage and distribute information relating to the daily lightning risk. They are to contact the Bureau of Meteorology or implement an early warning network for weather.

b. This information is to be distributed before work commences to all personnel and contractors by a prearranged means (e.g. text message with confirmation/ phone call and/or radio call) and displayed in the main office on the site notice board. It is also to be recorded on the Daily Pre-Start.

The details displayed on the board (updated as required) should consist of:

1. Designated person
2. Bureau of Meteorology website – www.bom.gov.au (This site is to be used as a guide only.).
3. Date / Time
4. Current Lightning Risk
5. Changing at (Information completed if known)

c. During the working day the Lightning Risk may change several times, it is the responsibility of the designated person to ensure all changes are forwarded to all relevant working parties.

d. In the event of a Lightning Risk all personnel should be made aware of the risk. They are to be vigilant and in the event of, or the near approach of, a lightning storm. All work on overhead power lines must cease immediately. Site staff are to descend the structures and retreat to vehicles, withdraw from site and await further instructions from a safe position

Note: A lightning risk is considered when a lightning storm is within 10kms of working personnel.

Appendix B. Safe Work Practices

1. GENERAL RULES

a) Wear insulated footwear – rubber or moulded soled boots (standard issue PPE footwear).

b) Apply and remove earths' correctly,

c) In all circumstances where there is a live line under-crossing or railway crossing (electrified), the towers on either side of the crossing must be earthed.

d) IEEE 524 (Guide to the Installation of Transmission Line Conductors) requirements must be followed at all times AS/NZS 7000 Overhead Line Design – Detailed Procedures (previously ENA C(b)1 Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines) provides further guidance on the subject.

2. INSULATED GLOVES AND TESTING REQUIREMENTS

a. Storage:

I. Gloves are to be stored unfolded, with the palms facing together and in an undistorted manner. E.g. no folds or creases.

II. Gloves are to be stored to ensure they are not exposed to direct sunlight.

III. Gloves are to be stored away from a direct source of heat and in areas where the temperature will not exceed 35C.

IV. When gloves are not being used, they must be stored in their dedicated protective bag in a location where they will not be subject to mechanical or chemical damage.

b. Issues:

I. Insulated gloves must have a minimum rating of Class 2 – 10kV.

II. Gloves are to be issued with a protective bag (canvas, plastic or leather), which must be clean and free of grease or oil, or other contaminates.

III. Gloves will be issued and allocated to a specific user and not transferred to any other user.

IV. Insulated gloves must be issued with Protective Leather Outers. These should be shorter than and worn over the insulating gloves.

V. If the Protective Leather Outer Gloves becomes damp, oily or greasy, they should be removed and replaced.

c. Examination and Testing Before Use:

I. Gloves must be inspected and tested prior to use and a record of such test entered into the log book stored with the glove.

II. Gloves must be visually inspected for cuts, tears, perishing or distortion prior to use.

III. Gloves must be pressure tested using the pneumatic glove tester on a weekly basis. Any loss of air indicates that the glove is defective.

IV. Defective gloves must not be used and these must be returned immediately to the stores for destruction.

V. Gloves are to be electrically tested on a 6 monthly basis by a competent and approved third party.

d. Working Requirements

Gloves are to be worn in the following circumstances:

I. When using hot sticks;

II. When hooking to a helicopter

e. Gloves Testing Regime

Equipment to be tested:	Visual inspection:	Electrical Test:
Insulated Gloves	Prior to use	Every 3 months

Visual Inspection – A visual inspection is conducted to ensure that there are no cuts, nicks, cracking or perishing. The gloves are checked by trapping air inside them, either manually or mechanically using a pump.

Visual Inspection – A visual inspection is conducted to ensure that there are no cuts, nicks, cracking or perishing. The gloves are checked by trapping air inside them, either manually or mechanically using a pump.

Electrical test – conducted by a competent and approved third party.

3. EARTHS AND TESTING REQUIREMENTS

I. Fault rated portable earthing, short circuiting and protective bonding devices shall be used by electrical workers whilst working on electrical apparatus, and includes such systems as:

II. Trailing earths, and

III. Rolling / running earths.

IV. Equipment earths

a. Descriptions/specifications

The purpose of portable earthing systems and protective bonding systems is to:

a. Short-circuit and conduct to earth any induced voltages;

b. Cause protection equipment to operate as rapidly as possible and provide maximum protection to electrical workers if the cable, line or equipment is energised unintentionally; and

c. Provide an equal potential work area by bonding together conductive parts to maintain a common electrical potential.

A portable earthing system and protective bonding systems generally consists of an assembly of the following components:

d. Conductors and clamps;

e. Means to apply the clamps;

f. Earthing attachment points; and

g. Where necessary mechanisms to ensure the clamps do not disconnect under fault conditions.

Portable earthing systems and protective bonding systems shall be rated for the fault level, in kA, and protection clearing time, in seconds, of the line or apparatus concerned.

Portable earthing systems and protective bonding systems should be clearly marked or labelled as follows:

I. Model or type reference for the device;

II. Manufacturer's identification;

III. Year of manufacture;

IV. Rated current and time; and

V. Conductor cross sectional area in mm2.

The manufacturer should provide the following information:

I. Appropriate type test reports (short-circuit type tests to use the methodology described in IEC 61230 or advise the customer of variations);

II. Explanations of markings and symbols;

III. Drawings and directions for assembly including torque values for fasteners and cable insulation details;

IV. Instructions for use and any associated risk assessments;

V. Guidelines for maintenance and inspection;

VI. Designed ambient temperature range;

VII. Any limitations/precautions for indoor/outdoor use; and

VIII. Other relevant information (for example, need to discard after exposure to fault current).

IX. As a minimum, dedicated earthing sticks shall be made of non-conducting material.

b. Inspections

I. Acceptance – on receipt of equipment, a process involving inspection or test, to ensure an item meets the required specifications.

II. Pre-use – before work commences, inspect or test items for suitability for purpose, signs of damage, deterioration or contamination, functionality, legibility of markings and that they are within current inspection and test dates.

III. Portable earthing systems shall be inspected for evidence of the following defects but not limited to:

i. Unapproved modifications;

ii. Clamps and connection fittings—broken, distorted or worn, contaminated, corroded, loose, arcing damage or seized;

iii. Crimp lug—inadequately crimped lugs (for example, Indent or V-crimp etcetera) or corroded;

iv. Conductor insulation—cracked, cut, brittle, damage due to overheating or abnormal swelling;

v. Conductor strands—broken (estimated at more than one percent of strands), corroded, strand separation (bird-caged), kinked or damage due to overheating; and

vi. Earthing sticks or applicators—broken or damaged.

Note: Portable earthing equipment subjected to the passage of a fault current shall be removed from service and treated as defective equipment.

When any item of equipment is found to be faulty or fails an inspection or test it shall immediately be withdrawn from use and marked or tagged as defective. The item shall not be used or reissued for use until it has been repaired and successfully reinspected or retested. Item is to be quarantined.

Items which cannot be repaired shall be destroyed or disabled so that they cannot be used.

Acceptance / Periodic – to ensure the serviceability of the portable earthing system, one of the following tests or detailed inspections shall be performed:

I. Resistance test (refer to American Standard ASTM F2249);

II. Combined resistance / temperature rise test as follows:

i. Apply a test current (between clamps so that all terminations are tested) appropriate to the rated current of the system under test as given in the following Table. Measure and record the resistance according to ASTM F2249. Any hot spots that may indicate high resistance should be investigated.

ii. A lug/cable interface inspection.

iii. The components of the lug/clamp assembly shall be examined for fatigue and corrosion that affect the performance of the portable earth system. Disassembly and reassembly of the components shall be in accordance with the design requirements.

c. Earths Testing Regime

Equipment to be tested:	Visual inspection:	Electrical Test:
Earths	Before each use	Every 3 months

I. Visual inspection – This is to include a check for any fraying of the leads, split insulation, cracking of the lug or other defect.

II. Electrical test – conducted by a competent and approved third party. (refer to American Standard ASTM F855)

4. HOT STICKS AND TESTING REQUIREMENTS

a. General

I. Hot sticks may be made entirely of insulating sections or comprise an insulating section and a handle section.

II. Insulating sections of hot sticks, if hollow or foam-filled, shall be designed to prevent moisture and contaminant ingress.

III. Telescopic sticks are made of retractable tubes and at least one insulating section.

IV. Operating sticks are used for operating work on live electrical apparatus and make actual contact with them. They may be fitted with a splined head or other fitting and are intended to be used under tension/compression and/or torque.

V. Measuring sticks are used to determine conductor to ground and conductor to conductor distances and other clearances. Dedicated measuring sticks are not intended to be used under tension/compression and/or torque.
A handle may be an integral part of the device or tool, or may be attached as required.
Minimum length of the insulating section of hot sticks should be appropriate to the voltage rating as prescribed in NENS 04, so as not to encroach on the Safe Approach Distances. However some reduction in total length due to ergonomic considerations may be possible.

VI. Each insulating stick shall be marked with the manufacturer's name or trademark.

Note: All hot sticks are to be marked with the maximum nominal phase to phase ac voltage on which it can be used.

b. Inspections

I. Acceptance – on receipt of equipment, a process involving inspection or test, to ensure an item meets the required specifications.

II. Pre use – before work commences, inspect or test items for suitability for purpose, signs of damage, deterioration or contamination, functionality, legibility of markings and that they are within current inspection and test dates.

III. Insulated hot sticks shall be wiped clean and treated with appropriate material to ensure hydrophobicity. The sticks shall be inspected for cracks, surface damage or mechanical defects. However, minor surface damage such as light scratches may be acceptable.

An end-to-end test should be considered with hot sticks that have enclosed hydraulic hoses.

c. Hot Sticks Testing Regime

Equipment to be tested:	Visual inspection:	Electrical Test:
Hot Sticks	Prior to use	Every 3 months

Visual Inspection – A visual inspection is conducted to ensure no cracks or other general defects are present which may allow water to ingress into the fibreglass. The coating or outside surface must be clean and in good condition.

Electrical test – conducted by a competent and approved third party

5. ANCHORAGE MAT

a. DESIGN REQUIREMENTS

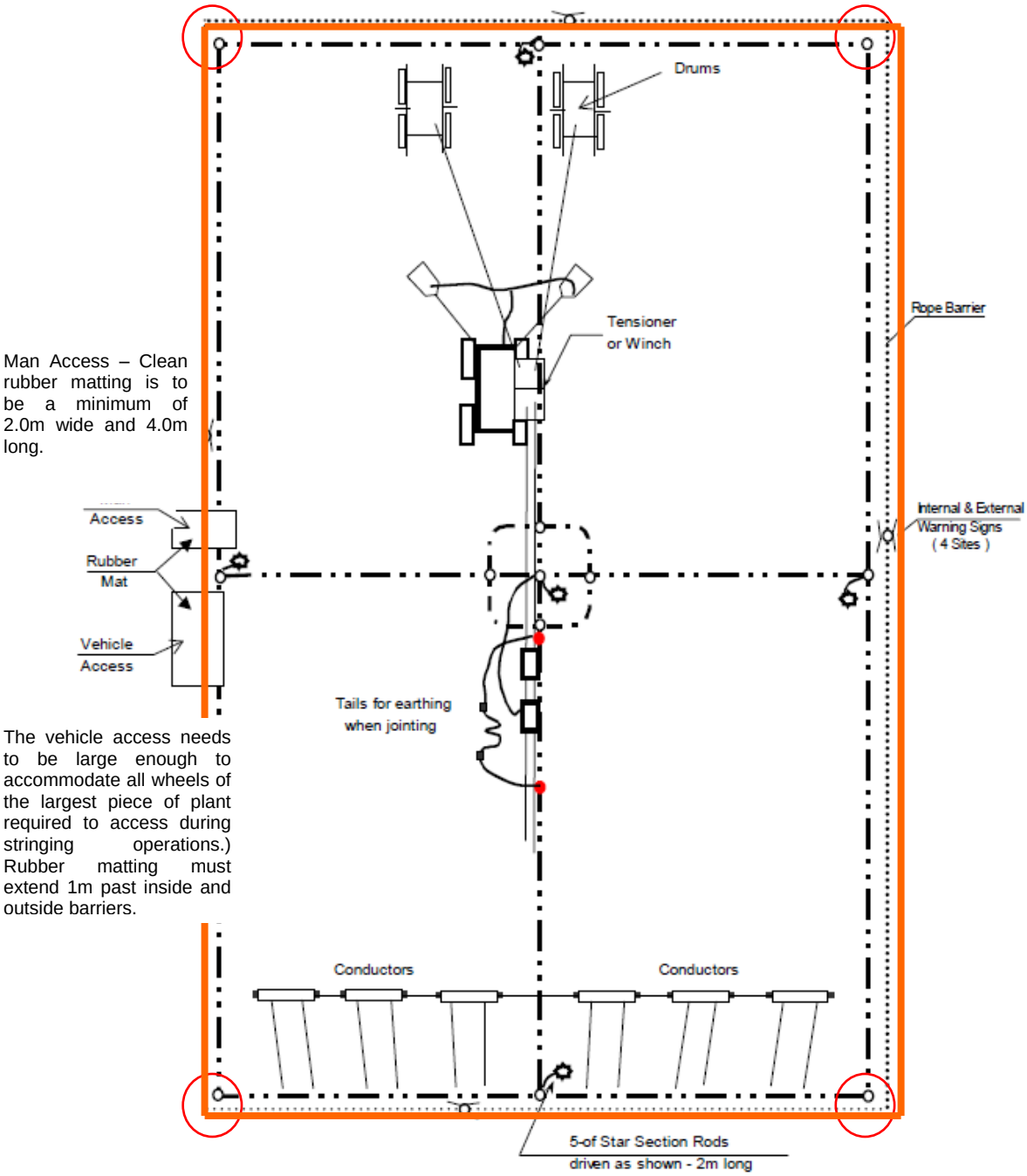
I. Prevailing site conditions will determine which option is selected by the Project Manager, Construction Manager, Engineer, and/or Stringing Supervisor.

II. Excavation permits are required for both Option 1 and Option 2 and are to be obtained prior to works commencing.

III. Earth stakes/spikes within the earth grid are to be driven to the appropriate depth to achieve the resistivity rating of 25 ohms (Ω) or less when tested. If this cannot be achieved, one or more stakes/spikes can be added until the rating is reached.

b. Option 1: Buried Earth Mat (preferred)

I. A buried earth mat shall be installed as shown in Figure 1.



6. Figure 1

II. Such mats shall consist of minimum 8mm diameter copper wire buried at a minimum depth of half a metre (0.5m) and completely enclose the work site.

III. A central earth stake shall be driven into the ground to the appropriate depth to achieve the resistivity rating of 25 ohms (Ω) or less when tested and shall be connected to the perimeter of the earth mat by four radial wires of similar size and material to the perimeter wire, buried at a depth of half a metre (0.5m) and laid along the longitudinal and transverse centre lines of the mat. (Refer WI-TL-S008D)

IV. The correct number of additional earth stakes shall be installed as per Figure 1 to enable all material, plant and equipment located within the perimeter of the mat to be earthed.

V. The stakes are to be driven to the appropriate depth to achieve the resistivity rating of 25 ohms (Ω) or less when tested and shall be solidly connected to one of the mat's radial earths. (Refer WI-TL-S008D)

VI. Workers and equipment may pass onto the mat only by means of access ways for workers and vehicles. Suitably approved and rated rubber mats, minimum 2m wide, are to be used for these access ways,

VII. Vehicles must not remain stationary partly on the grid and partly on the ground, or in a position on the grid where personnel can touch both the vehicle and the ground at the same time. Before exiting the vehicle an earth is to be applied.

VIII. A twin barrier will be placed around the perimeter of the earth mat with warning signs placed on each side as well as the entry and exit points. The first barrier should be just off the edge of the earth mat and the second barrier should be a minimum of two metres (2m) out from the first and 1.5m high to mitigate touch potential.

SAFETY NOTES:

- Where strung conductors are low, such as outside the tensioner earth grid and over scaffolds do not touch the conductor unless it is absolutely necessary. Where it is necessary to touch a conductor during stringing, first stop the winch, and then apply a local earth, so as to 'box' yourself in, using a hot stick before attempting to touch the conductor.
- Equipment placed on the earth grid must be directly earthed to a stake solidly connected to the anchorage mat.
- Personnel must remain clear of the conductor outside of the barriers surrounding the earth mat at all times during lifting and cutting operations. This is to be achieved using fences, barricading and sign posting as deemed appropriate for each work site.
- No personnel and/or vehicles are to enter or leave the equal potential zone whilst machines are operational or conductors are being pulled. The entry/exit point is to be blocked before works commence.
- Not more than 1 (one) vehicle or person shall utilise the designated entry/exit point at any one time. This is to eliminate step potential.

c. Option 2: Wire Earth Mat

I. A steel wire earth mat shall be installed as per details in Appendix A. The checklist in Appendix A needs to be completed once this earth mat is installed and before pulling conductor. Resistance testing is to be completed and recorded on this schedule.

II. Use steel mesh of size 50 x 75 x 6mm as an earth mat, with varying sizes of sheets available, either 2.4 x 3m or 2.4 x 6m. Sheets are bonded together with u bolts. The earth mat size will be installed as per the site requirements.

III. Note: This size mesh is recommended to help eliminate slips, trips, and falls. It will also need to be galvanised to prevent rusting.

IV. Earth rods shall be driven into the ground to the appropriate depth to achieve the resistivity rating of 25 ohms (Ω) or less when tested and shall be connected to the perimeter of the earth mat by radial earths of similar size and material to the perimeter wire, laid along the longitudinal and traverse centre lines of the mat. (Refer WI-TL-S008D)

V. A sufficient number of additional earth stakes shall be installed to enable all material, plant and equipment located within the perimeter of the mat to be earthed. Such stakes shall be driven into the ground to the appropriate depth to achieve the resistivity rating of 25 ohms (Ω) or less when tested and shall be solidly connected to one (1) of the mat's radial earths. (Refer WI-TL-S008D)

VI. Workers and equipment may pass on to the mat only by means of access ways for workers and vehicles. Suitable rubber mats, minimum 2m wide and 1m past inside and outside barriers, are to be used for these access ways.

VII. Vehicles must not remain stationary simultaneously on both the grid and on the ground, or in a position on the grid where personnel can touch both the vehicle and the ground at the same time.

VIII. A twin barrier will be placed around the perimeter of the earth mat with warning signs placed on each side as well as the entry and exit points. The first barrier should be just off the edge of the earth mat and the second barrier should be a minimum of two metres (2m) out from the first and 1.5m high to eliminate touch potential.

SAFETY NOTE:

- Where strung conductors are low, such as outside the tensioner earth grid and over scaffolds do not touch the conductor unless it is absolutely necessary. Where it is necessary to touch a conductor during stringing, first stop the winch, and then apply a local earths, so as to 'box' yourself in, using a hot stick before attempting to touch the conductor.
- Equipment placed on the earth grid must be directly earthed to a stake solidly connected to the anchorage mat.
- Personnel must remain clear of the conductor outside of the barriers surrounding the earth mat at all times during lifting and cutting operations. This is to be achieved using fences, barricading and sign posting as deemed appropriate for each work site.
- No personnel and/or vehicles are to enter or leave the equal potential zone whilst machines are operational or conductors are being pulled. The entry/exit point is to be blocked before works commence.
- Not more than 1 (one) vehicle or person shall utilise the designated entry/exit point at any one time. This is to eliminate step potential.

d. Testing Regime for Rubber Mats

Visual Inspection – A visual inspection is conducted to ensure that there are no cuts or nicks, or any cracking or perishing. The mats are to be rolled in all directions and on both sides.

6. EARTHING PROCEDURE

Insulated gloves, must be worn whilst handling earths.

h. Method of applying/removing an earth

i. When applying an earth, always apply to the tower or earthed end first. Then apply the conductor clamp using the hot stick provided.

ii. 9.1.2 When removing an earth, always remove the potential live end first using the hot stick provided and then lift clear of the conductors; only then is it safe to remove the tower or earth end.

iii. 9.1.3 With bundled multiple conductors, an earth must always be applied to all the conductors in the bundle individually.

iv. Appendix B – Schedule of earths must be completed prior to installation, during installation and during removal of all earths required to be installed on the line. This document is to remain 'live' throughout the entire process.

v. Earth identification/serial numbers must always be recorded.

SAFETY NOTE:

- An induced voltage will build up from point of source to final destination.
- For example, if generated at point A and transmitted along a power line to point B, the induced voltage would increase gradually from point A to point B along an adjacent power line.
- As such the direction of power flow must be ascertained and earths installed from the source direction to the final destination, reducing induced voltage each time.
- Earths should then always be removed in the opposite direction.

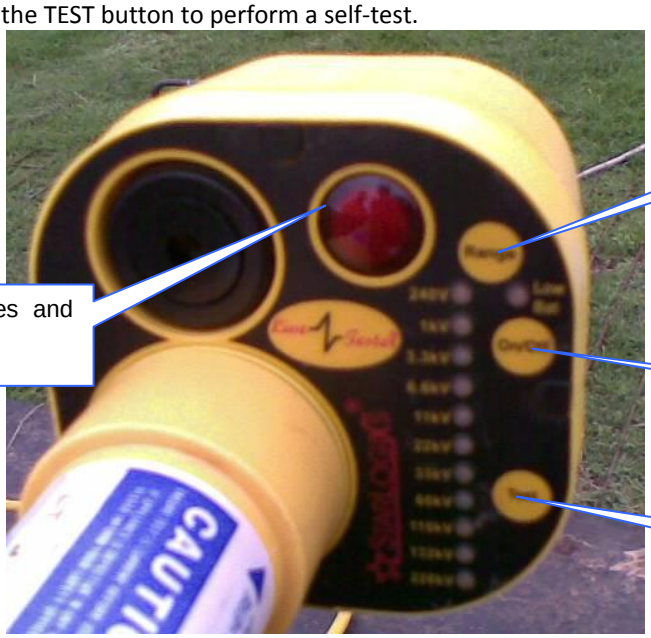
- This direction of flow is to be given by the electricity supply authority or asset owner.

IEEE 524 requirements must be followed at all times.

7. Example of correct VDU use.

i. Attach VDU unit to Live Line stick.
ii. Press the On/Off button to activate the VDU
iii. Press the TEST button to perform a self-test.

Turning VDU on and checking



iv. Select the correct voltage for the conductor

v. Place the VDU with close proximity to each conductor being tested within the circuit.

vi. Once the VDU is on or near the conductor it should remain silent if the conductor is de-energised or the following will happen if the circuit is energised

1. Red Light Flashes and Siren Chirps - Circuit is still live. Do not apply temporary earth.
2. If phase is proven to be energised, descend structure immediately and check with appropriate authority.

vii. An additional self-test must be performed immediately following 5.5.6 to ensure the VDU is still functioning correctly.
viii. The test should then be repeated from the lowest voltage range up to the nominal phase voltage or until a reading is not produced and the maximum result recorded on the earthing permit. If 'No Voltage' is recorded at 11kv then no further test of the conductor is required.
ix. Record the initial results for each reading on **POW-2F-138-01 Temporary Earthing Record – Structures**

8. Definitions:

Refer to Energy Networks Association Doc 001 – National Electricity Network Safety Code **for definitions.**