

Bridge Earthing

Safe Work Handbook

Power System Safety Rules



This Handbook covers the Power System Safety Rules requirements for Bridge Earthing. The handbook aims to help you understand the requirements for Bridge Earthing at Substations or on Transmissions Line easements.

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

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

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

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Introduction

If earthing systems are damaged, electrical performance may be affected and dangerous voltages may occur.

Where work includes the connection, cutting, disconnection or potential to break or damage any part of an earthing system, then prior to the work commencing a bridging lead must be applied across the point of work. This handbook should be used to manage the hazards involved.

It's essential reading for anyone working on or in the vicinity of an earthing system on Transgrid's High Voltage (HV) network. It aims to prepare you for the HV network environment and reduce your risk when working on or around an earthing system.

This handbook is the main resource for obtaining the **Bridge Earthing TL Structure** and **Bridge Earthing Grids** authorisations via the Worker Safety Authorisation and Training (WSAT) system. It supports training courses, which you must pass to get your worker authorisation.

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

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

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

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

Authorisations

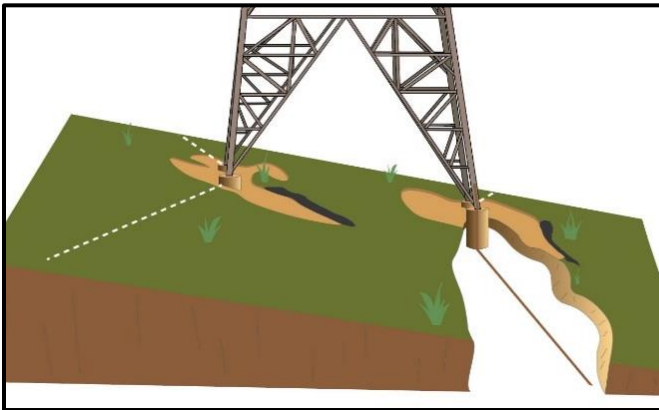
Specific Functions	The Power System Safety Rules (PSSR) authorisations are permissions to access an area, perform a type of work, apply a specific control, or execute a controlled process.
Bridge Earthing TL Structure	Getting your PSSR authorisation is a journey and depending where you will be working on our High Voltage Network, you might get one authorisation or many.
Bridge Earthing Grids	A PSSR authorisation gives you access to work but also brings responsibility. It's a commitment between you and Transgrid to work safely and look out for each other. When you get your authorisation, do not abuse, or misuse it. If you do, you may lose your authorisation and access to work at Transgrid.

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

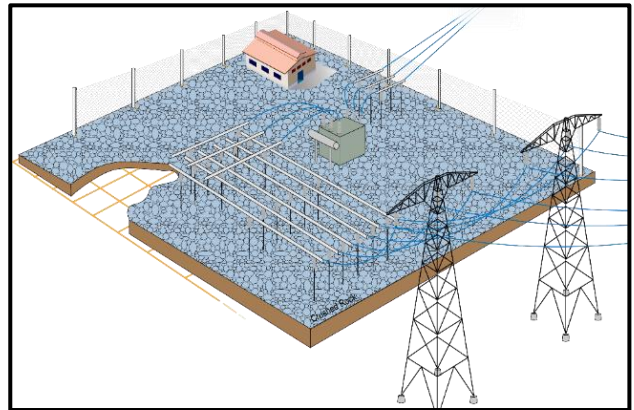
Earthing Systems

Bridging of earthing systems must be carried out before any connection, cutting, disconnection or potential to break or damage any part of an earthing system is performed. Bridging earths are intended to prevent exposure to dangerous voltages in the event of a break in the earthing system.

Earthing systems within Transgrid's operational network can be categorised into either:



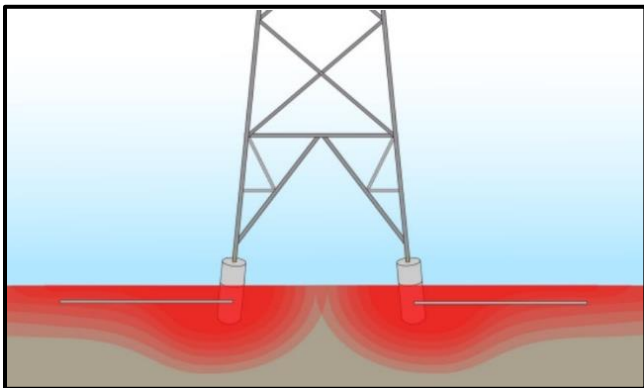
Transmission Line Structure earthing systems



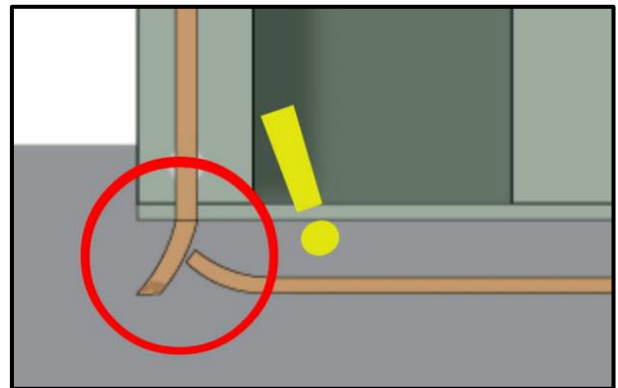
Substation Earthing Grids

Why are Earthing Systems Hazardous?

Earthing systems aim to provide surfaces that are near zero potential. If an earthing system is damaged, dangerous potentials (voltages) may occur.



In the event of a fault, the earthing system provides a path to earth for fault currents. The earthing system also limits the voltage gradients experienced around the structure.



If an earth or neutral on in-service HV apparatus is disconnected, a dangerous potential difference of a few kV may be present.

If you identify any broken earth connections, you should report it immediately and prevent anybody from coming into contact with it until the break is bridged and repaired.

Bridge Earthing Equipment

For your safety, you must use the following equipment when applying or removing earth bridging:

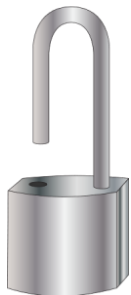
Insulating handle



Bridging leads must be applied using an insulated MT-815S application handle or a suitable CATU operating stick.

Locks and Tags

Each clamp of the bridging lead must be locked and a Do Not Operate Tag attached to explain its purpose.



Locks

Bridge TL Structure Earthing – ‘N1’ or other suitable lock.

Bridge Substation Earthing Grids –‘O1’.

Lockout Hasp

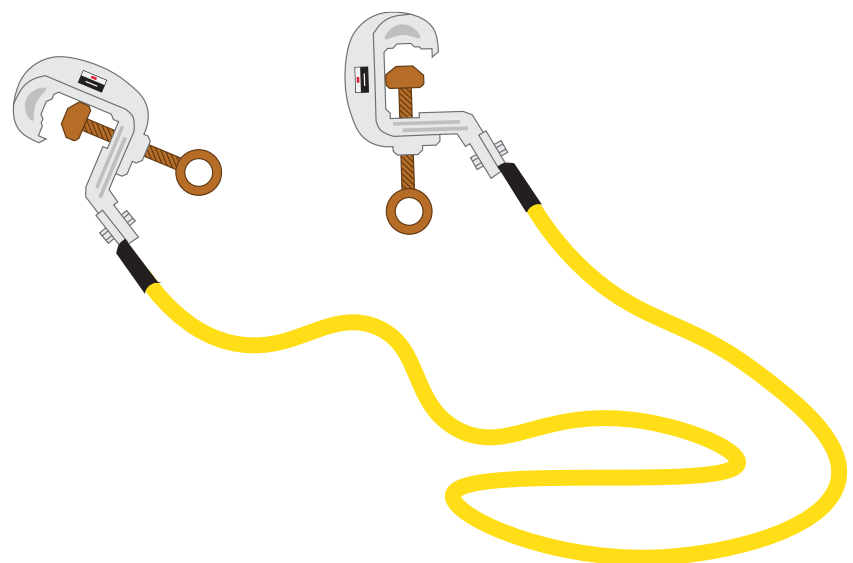
A lockout hasp is used to lock the CATU MT-815S clamps. The larger end closes over the earth lead while the smaller end closes through the ring of the CATU clamp. A lock is then applied in one of the available holes.



Portable Earth Lead

You must use an approved portable earth lead for bridging earthing with CATU MT-815S clamps on either end.

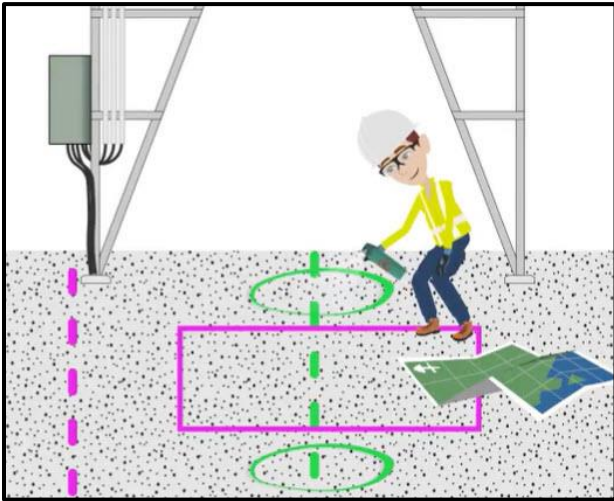
The earth must have been electrically tested within 3 years and be visually inspected prior to application.



More info

[Portable Earthing Of High Voltage Conductors](#)

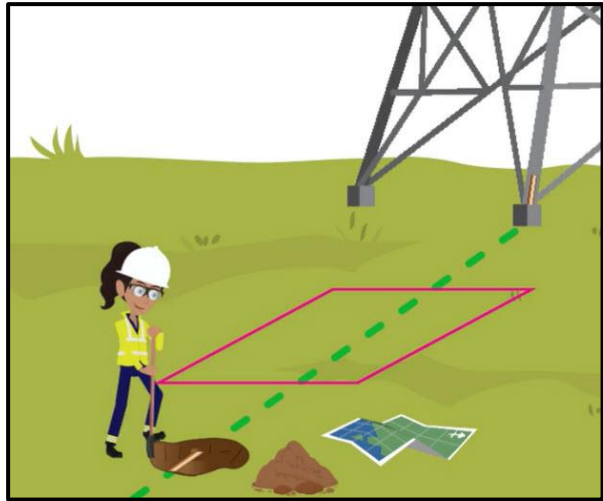
Bridge Earthing Principles



Prior to excavation work, Transgrid approved drawings should be referenced to identify the earthing system layout.

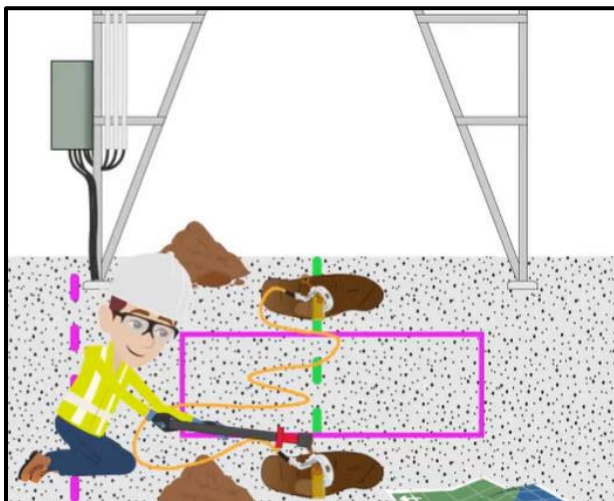
Where the work involves the connection, cutting, disconnection or potential to break or damage the earthing system, bridging must be applied.

Identify the expected location of the earthing grid and suitable locations for potholing to apply the bridging lead.

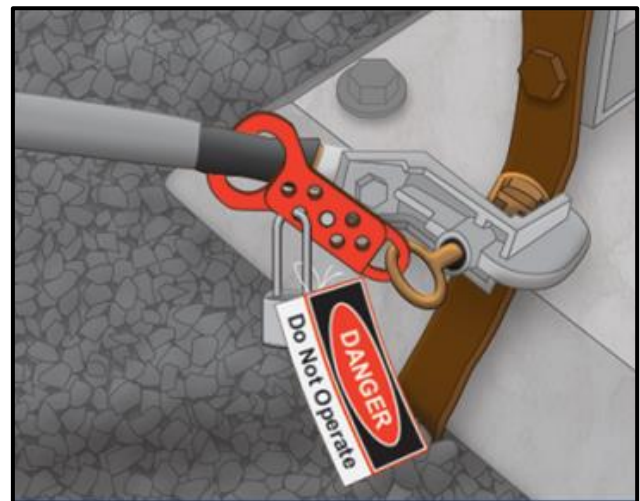


Potholing is when you expose a section of the earthing system using non-mechanical methods such as using a shovel. Take care that you do not damage the earthing system while digging.

So that bridging leads may be placed where they will not interfere with excavation work, potholes should be dug outside of the area to be excavated.



To reduce the hazard of dangerous voltages that may be present, bridging leads must be applied and removed using an approved insulating handle.



When you are locking the clamp of a bridging earth, you first apply a red hasp. Close the large end around the earth lead and the small end through the ring of the CATU clamp.

You must apply an approved lock through one of the smaller holes in the middle to prevent the hasp from opening. A Do Not Operate tag must also be attached to explain its purpose.

Specific Functions

Bridge Earthing TL
Structure

Bridge Earthing Grids

Bridge Earthing - Transmission Line Structure

Where the work involves the connection, cutting, disconnection or potential to break or damage a transmission line structure leg earthing system, then prior to the work commencing a person authorised [Bridge Earthing TL Structure](#) must ensure bridging is applied in accordance with the procedures outlined in this handbook.

Structure Leg Earthing Safety

As well as having an earth strip or stakes at the base of the structure, the earthing system for a transmission line structure is connected to switchyards at the ends of the transmission line by an overhead earth wire (OHEW).

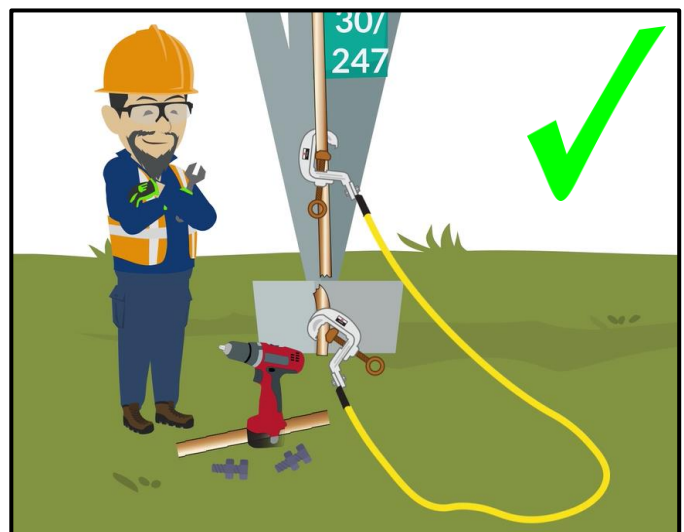
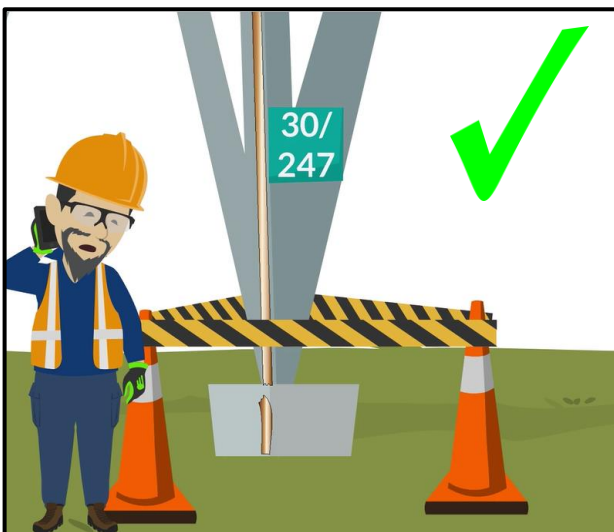
The earthing system reduces the likelihood of lightning causing transmission line insulator flash overs and provides a reduction in voltage gradients adjacent to the structure legs.

OHEW bridging must be carried out in line with Transmission Line work requirements.



There is a risk of dangerous potentials (voltage) being present if a structure leg earthing system connection is cut, disconnected, or broken.

If a structure leg earthing is damaged or found to be damaged, persons must be prevented coming into contact with the broken earth connection until a person authorised [Bridge Earthing TL Structure](#) applies a bridge to the broken earthing so it may be repaired safely.



Checking for other services

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

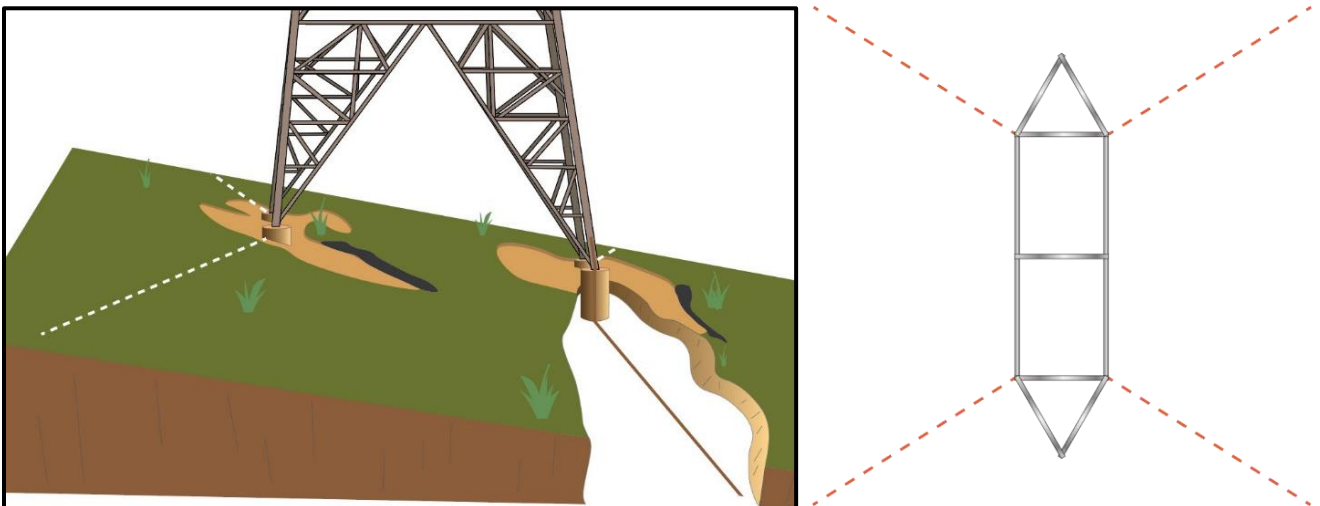


Assessing Electrical Pathways

The earthing systems on Transgrid's transmission structures vary depending on the type of tower and the route of nearby lines. Typical systems used:

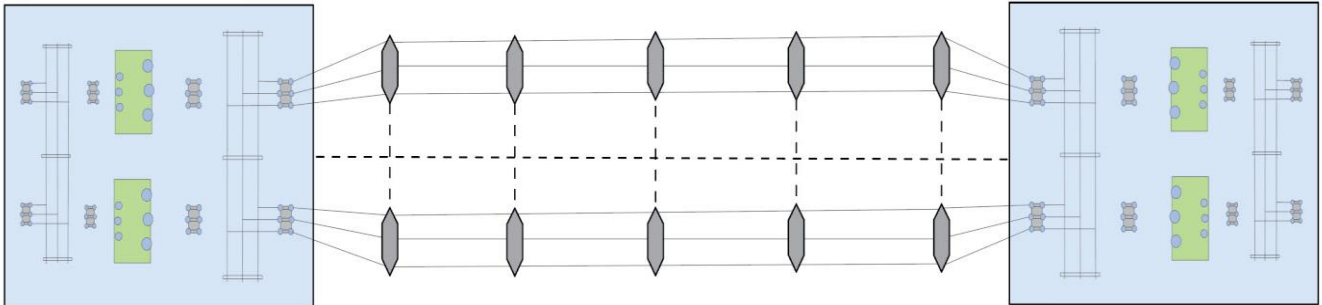
Radial counterpoise earthing

For the majority of steel tower structures, earth straps are normally connected to each of the legs and extended outwards at 45-degrees.



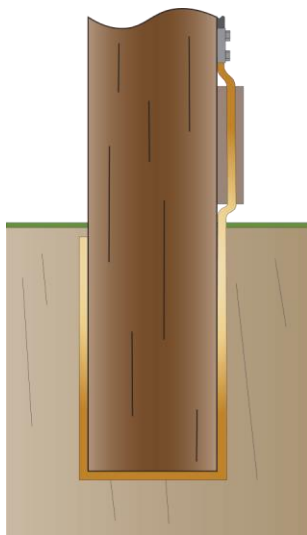
Parallel Counterpoise Earthing

At a few unique sites, the earthing from parallel lines is connected to a common earth conductor that runs underground from one substation to the other.



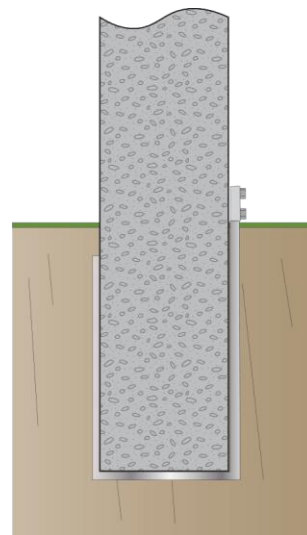
Pole structures

Pole type structures normally have a single earth strip extending around the butt of the pole.



Single wood pole

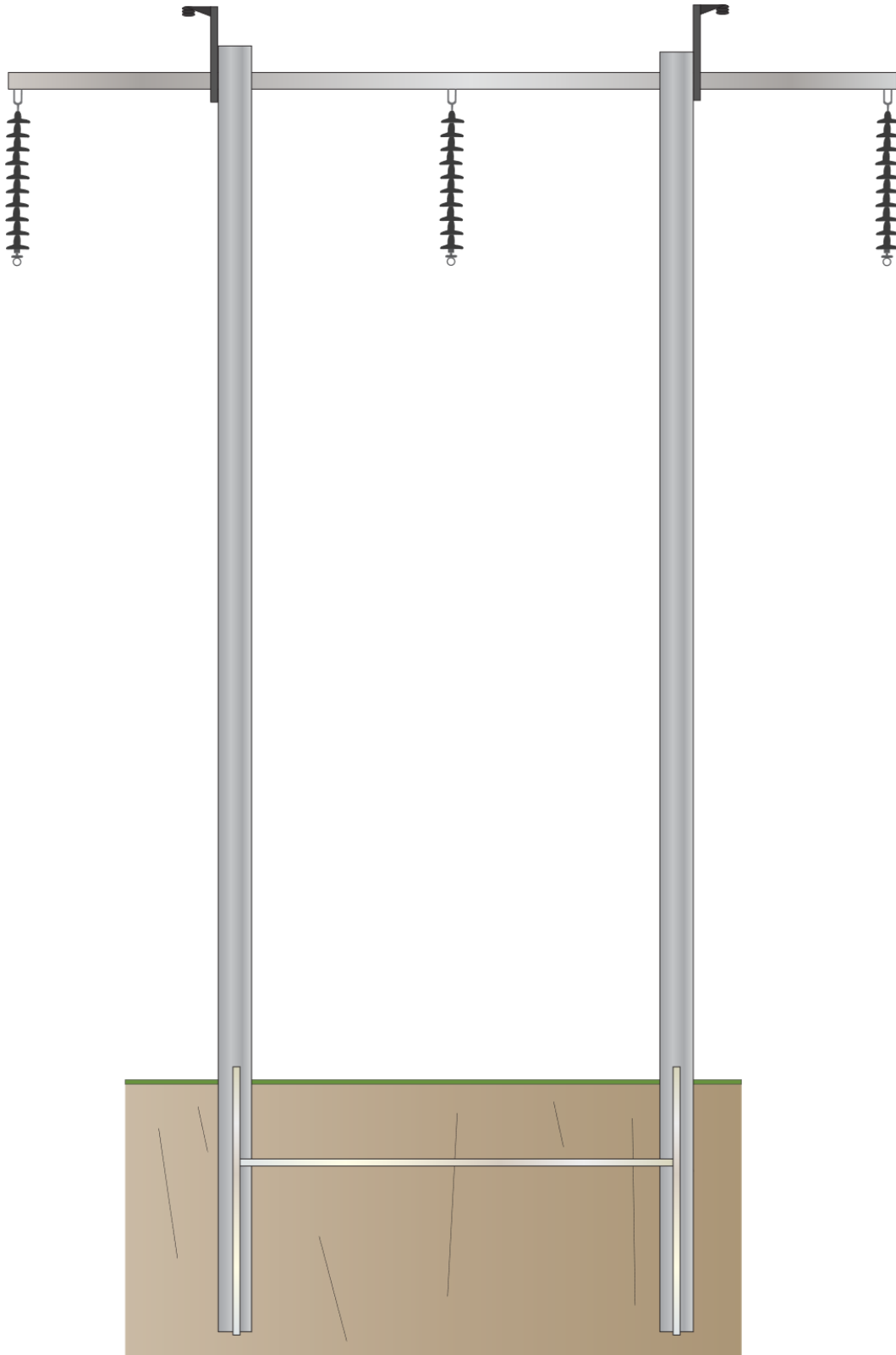
The earth strip wraps around the butt of the pole and connects to the structure earth mounted externally on the pole. The strip is generally constructed from copper.



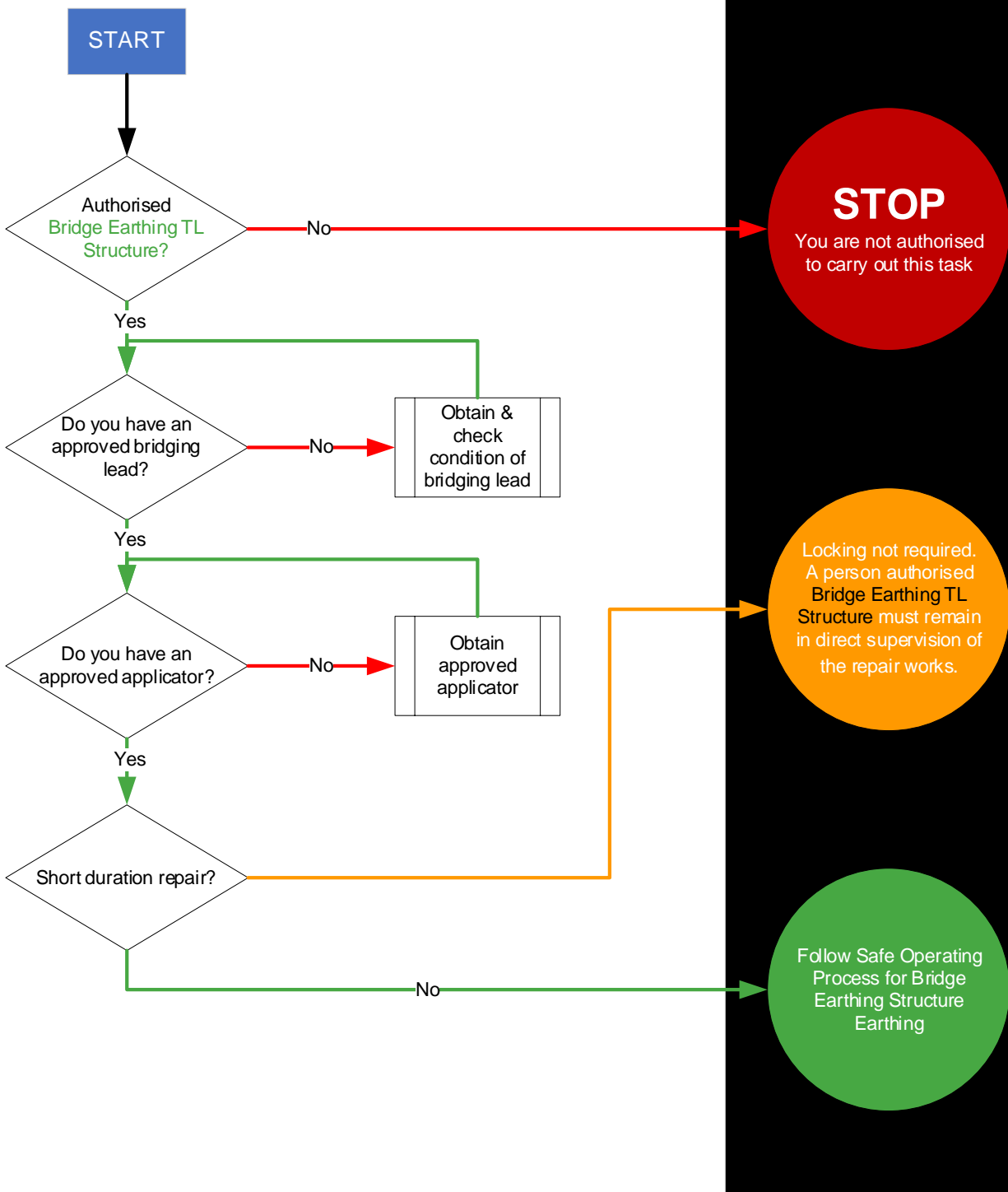
Single concrete pole

The earth strip wraps around the butt of the pole and connects to the structure earth mounted internally on the pole. The strip is generally constructed from stainless steel.

On multiple pole structure arrangements, there may also be an underground earth strap connecting the earthing between the poles.

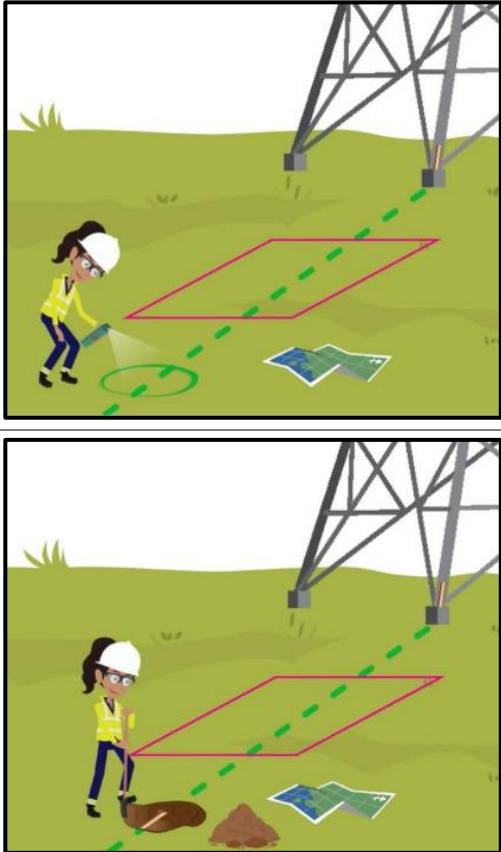
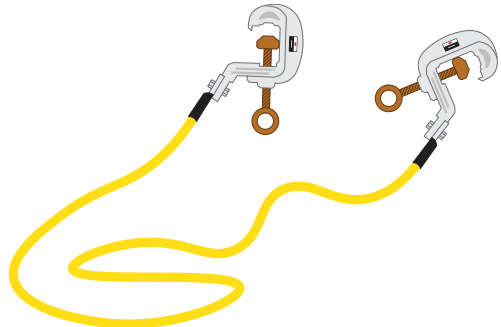



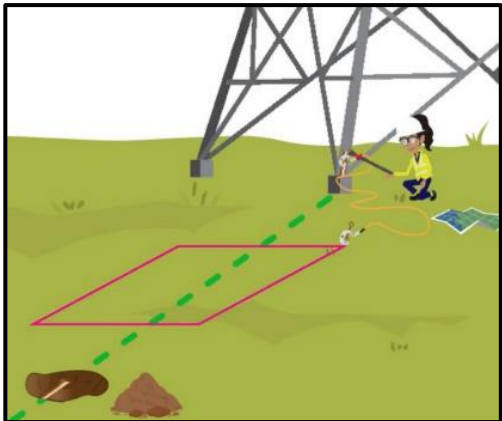
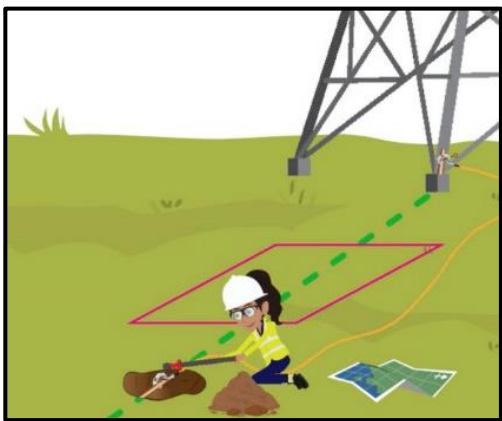
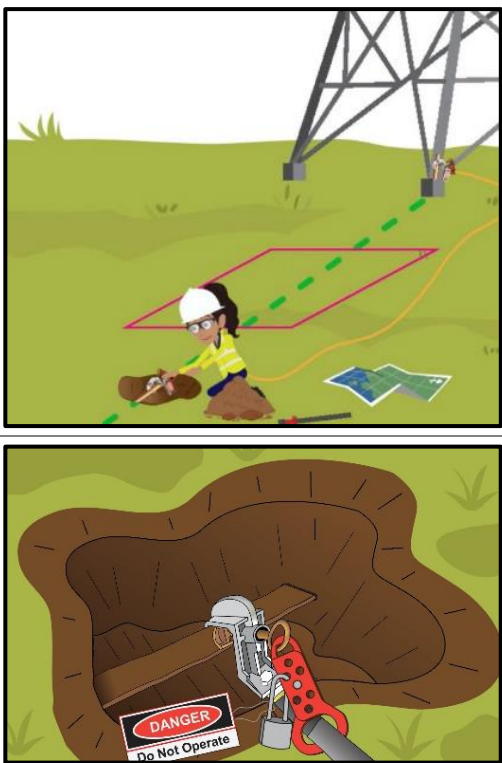
Hazard Assessment - Structure Leg Earthing



Safe Operating Process

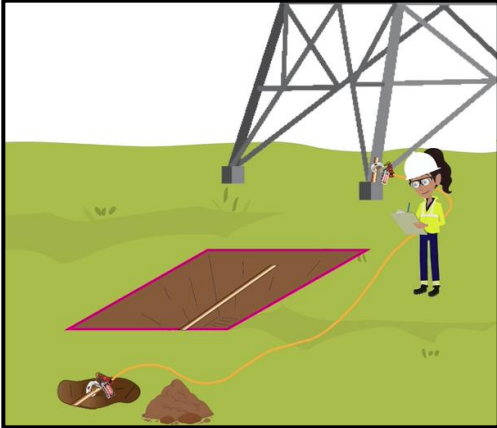


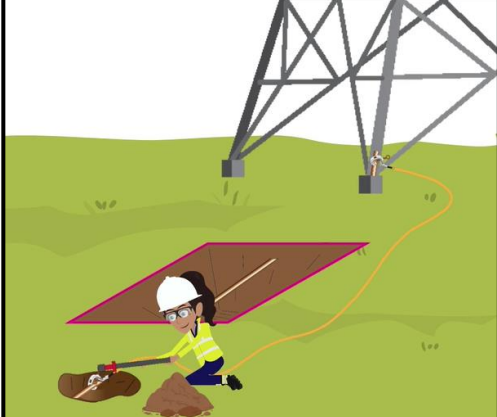
Installing a structure earthing bridge lead

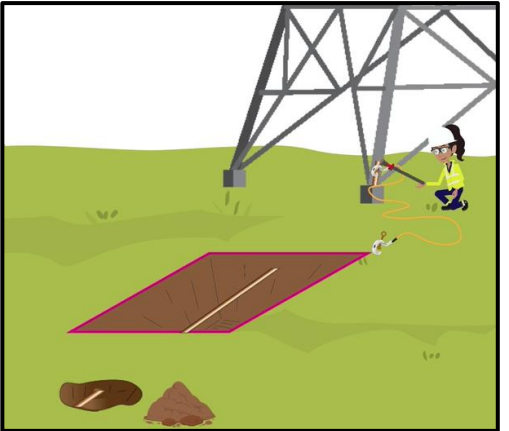

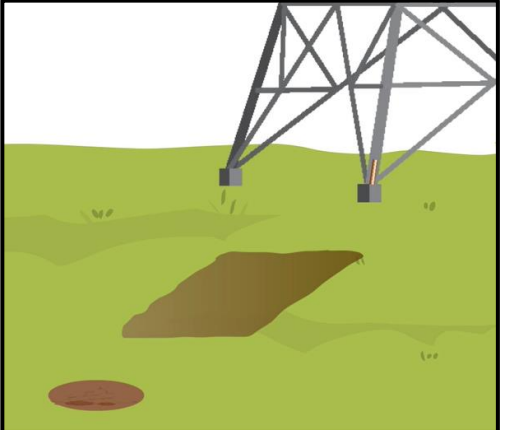
Job Steps	Hazards	Controls	
<p>Identify safe connection points for the bridging lead.</p>	<p>Hazardous voltages from broken or disconnected structure earthing.</p>	<p>Ensure broken or disconnected structure earthing is not contacted with the body or other equipment.</p>	
<p>Obtain bridging lead.</p>	<p>Bridging lead not fit for purpose.</p>	<p>Use standard portable earthing lead with CATU MT-815S clamps. Confirm assembly, condition and maintenance .</p>	
<p>Obtain bridging lead applicator.</p>	<p>Uninsulated applicator not fit for purpose.</p>	<p>Use approved application tool. Confirm assembly and condition.</p>	

<p>Attach bridging lead to the first point of connection.</p>	<p>Hazardous voltages.</p>	<p>Using applicator to keep hands and body clear of bridging lead clamps and earthing.</p>	
<p>Attach bridging lead to the second point of connection.</p>	<p>Hazardous voltages.</p>	<p>Using applicator to keep hands and body clear of bridging lead clamps and earthing.</p>	
<p>Lock and tag.</p>	<p>Hazardous voltages caused by the removal of bridging lead prior to restoration of the earthing.</p>	<p>Apply locks and Do Not Operate tags to each clamp of each bridging lead to explain its purpose.</p>	

Locks are not required when the bridging lead is applied for a short duration while repairs to the structure earthing system are completed. The person authorised Bridge Earthing TL Structure must remain in direct supervision of the repair works.

Removing a structure earthing bridge lead

Job Steps	Possible Hazards	Controls	
<p>Confirm that it is safe to remove the bridging lead.</p>	<p>Hazardous voltages from broken or disconnected earthing.</p>	<p>Ensure the parallel connection is restored or another bridging lead is installed in parallel.</p>	
<p>Remove locks and Do Not Operate Tags from each bridging clamp.</p>	<p>Incorrect bridging lead removed.</p>	<p>Confirm the Do Not Operate tag description matches your understanding.</p>	
<p>Obtain bridging lead applicator.</p>	<p>Hazardous voltages.</p>	<p>Use approved application tools.</p>	
<p>Remove the bridging lead from the first point of disconnection.</p>	<p>Hazardous voltages.</p>	<p>Using applicator, keep hands and body clear of bridging lead clamps and earthing.</p>	

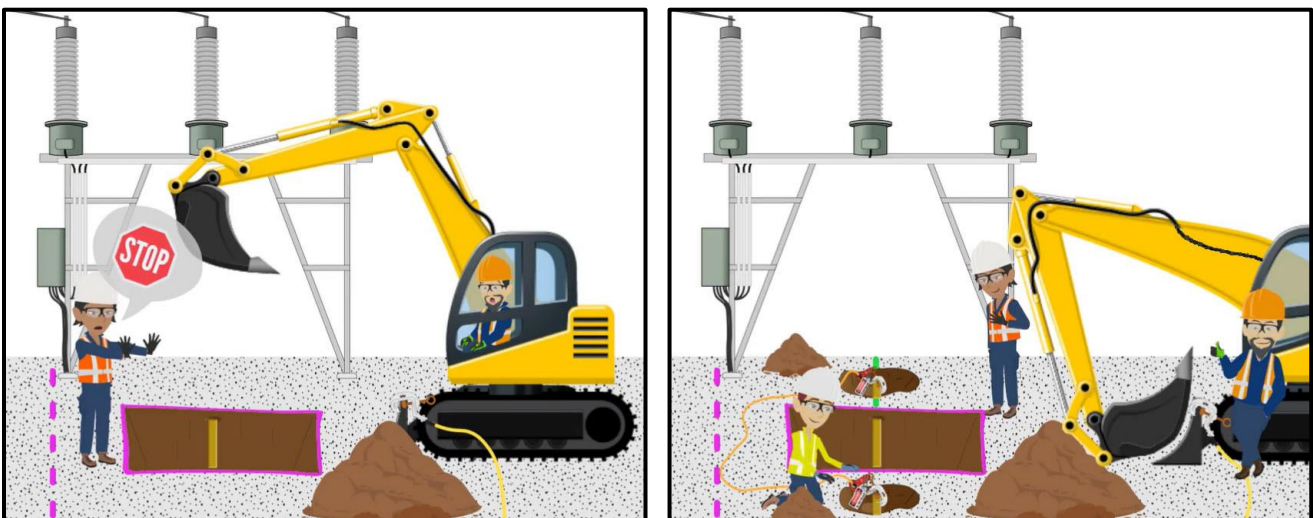
<p>Remove the bridging lead from the second point of disconnection.</p>	<p>Hazardous voltages.</p>	<p>Using applicator, keep hands and body clear of bridging lead clamps and earthing.</p>	
<p>Area may be restored.</p>			

Bridge Earthing Grids

Where the work involves the connection, cutting, disconnection or potential to break or damage any part of a substation earthing system, then prior to the work commencing a person authorised **Bridge Earthing Grids** must ensure:

- (a) Connections between the earthing system and transformer neutrals or High Voltage cable sheaths are not disconnected except under Access Authority conditions;
- (b) Bridging is applied across the point of work unless working under Access Authority conditions;
- (c) Bridging leads are applied and/or removed using an approved insulated working method;
- (d) The clamps of each bridging lead are locked and a Do Not Operate Tag is affixed to each clamp to explain its purpose;
- (e) Earthing grid bridging is only removed after:
 - (i) The parallel connection has been restored;
 - (ii) Other bridging has been installed in parallel; or
 - (iii) It is confirmed that is safe to do so.

Earth Grid Safety

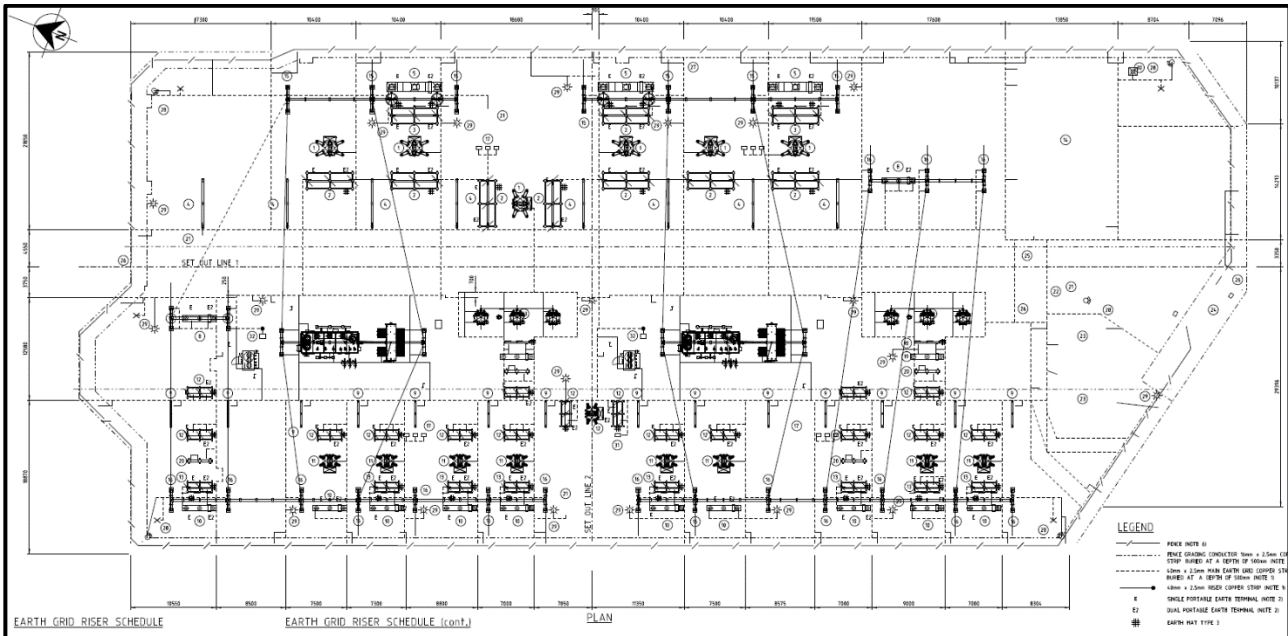


If a work crew uncover an unidentified section of the earth grid while excavating, the work crew must **STOP** work.

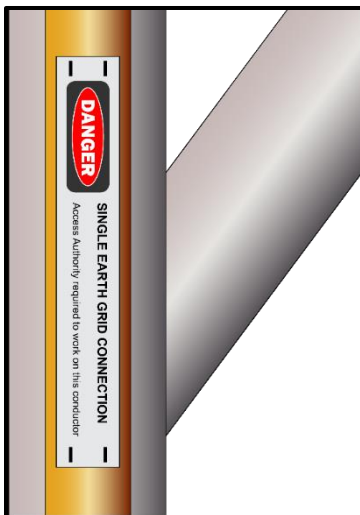
A person authorised **Bridge Earthing Grids** must assess the earthing grid electrical pathways at the excavation site and if required, apply bridging leads.

Assessing Electrical Pathways

To properly assess the earthing grid electrical pathway, you must review the site earthing layout diagram.



Single earth connections from HV apparatus to the grid are normally identified with signage but must be confirmed via the site earthing layout diagram, as cutting or breaking a single run earthing grid to an earth or neutral on in-service HV apparatus may cause a dangerous potential (voltage) to occur.



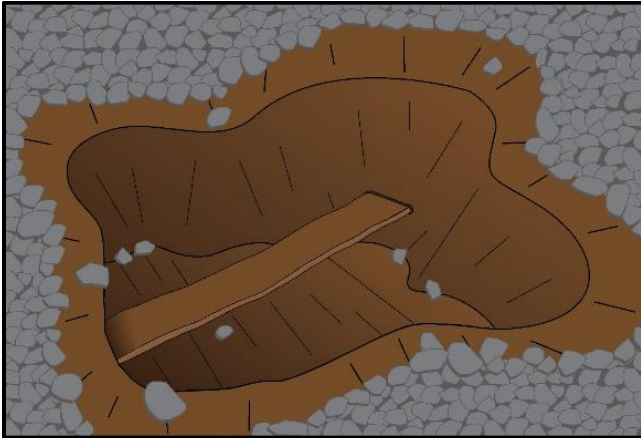
Single earth connections from HV apparatus are typically found on transformer neutrals, and HV or Transmission cable sheaths.

Unless the HV apparatus is out of service and under Access Authority conditions, you must not apply bridging leads to cut or break these single runs of earthing grid.

Bridging connections

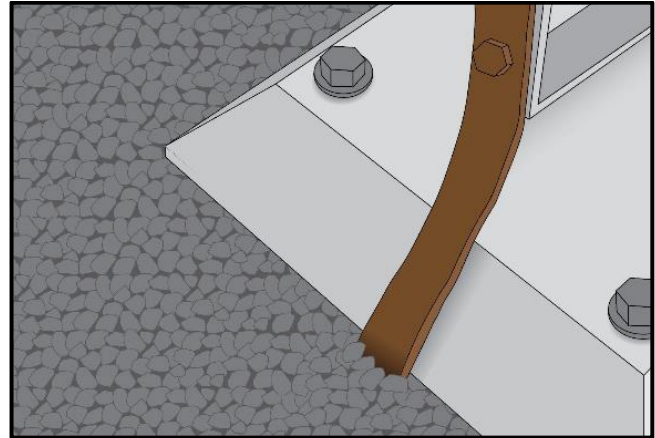
Review the earthing layout diagram to assess where earth bridging will be required for the work activity and identify suitable connection points for the bridging. Suitable connection points may be:

Underground



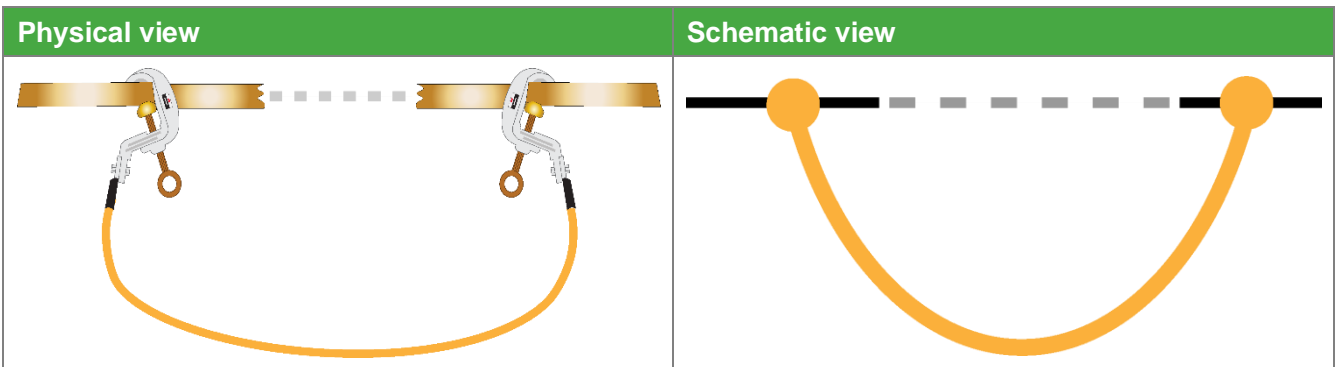
The grid may be uncovered by potholing using non-mechanical methods such as digging with a shovel. Care must be taken so the earth grid is not damaged while digging.

On structures

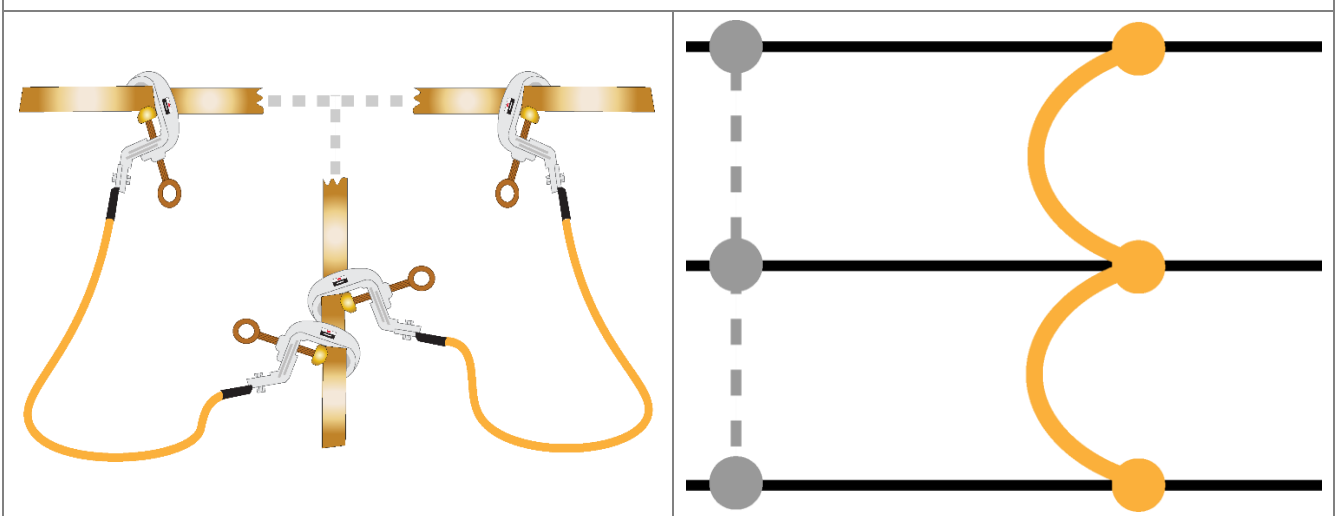


Structure connections to the earth grid run above ground, generally along the concrete footing and often allow any easy connection for earth grid bridging.

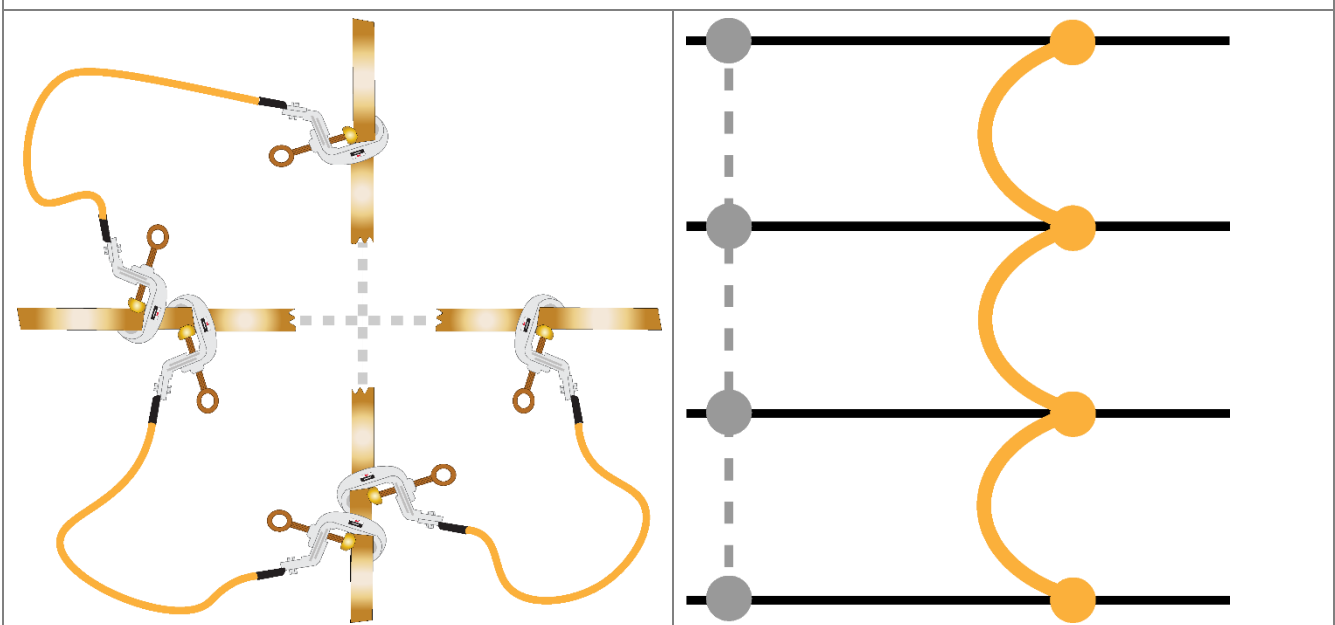
As you may need to bridge across grid intersections, it is important to understand electrically how many bridges are required to sufficiently apply bridging to the earthing grid.



Only a single bridging lead is required when bridging a single run section of earth grid.

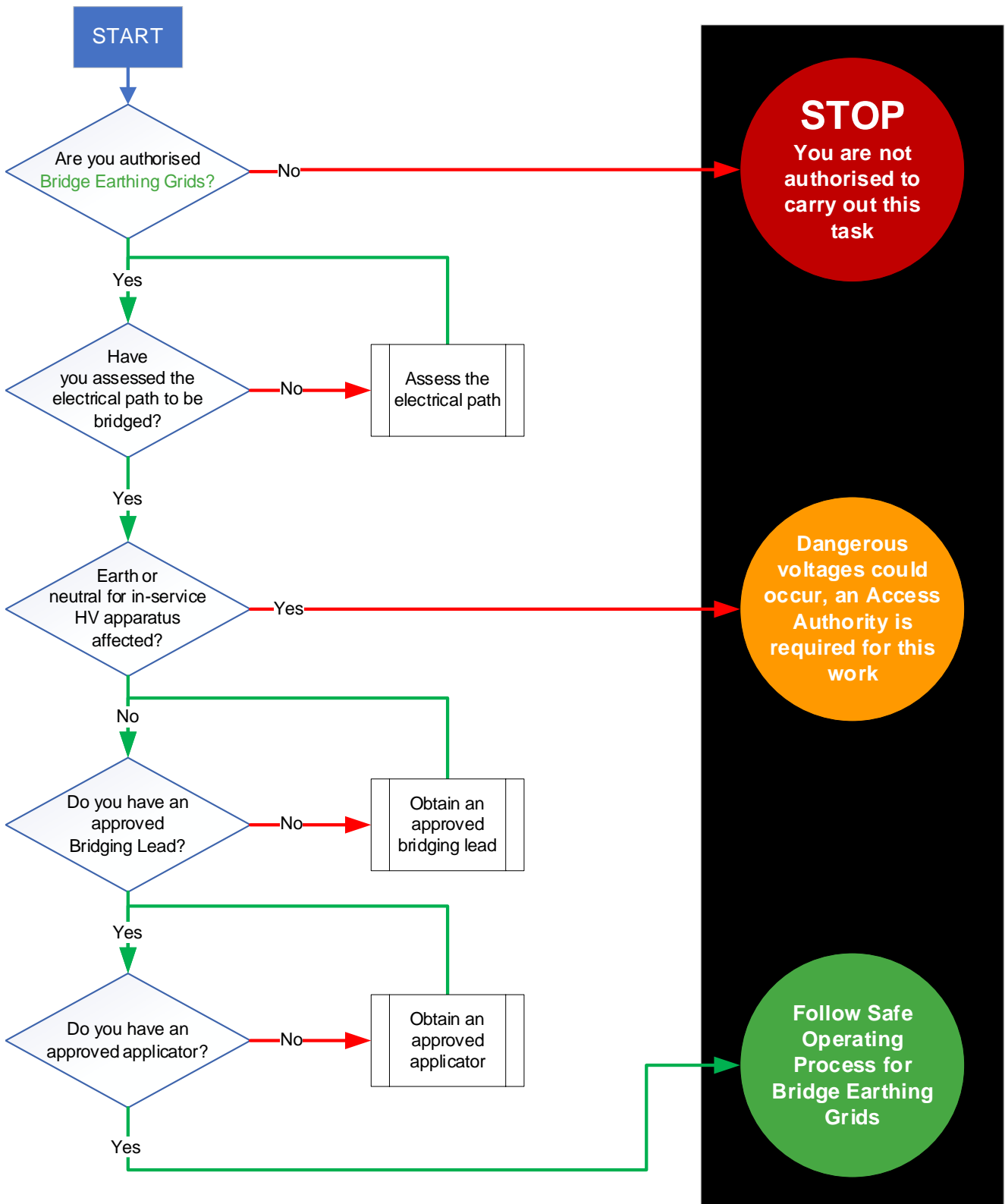


When bridging a T intersection, two bridging leads are required.



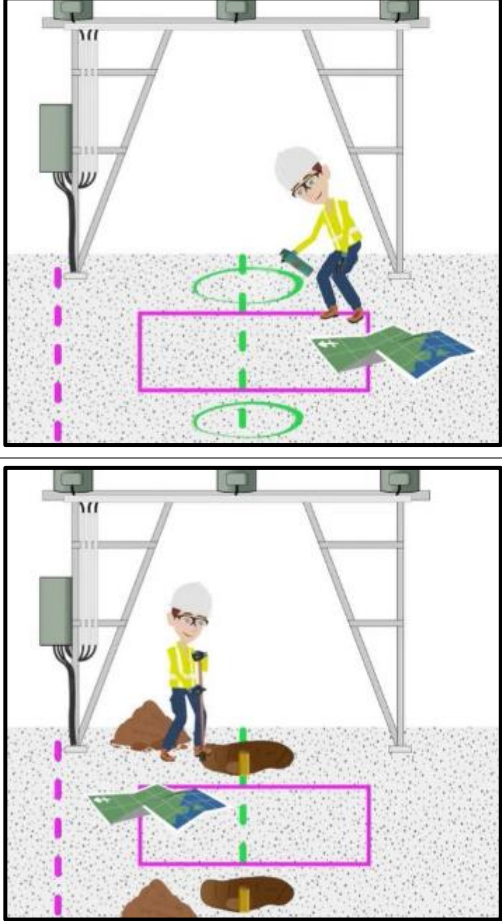
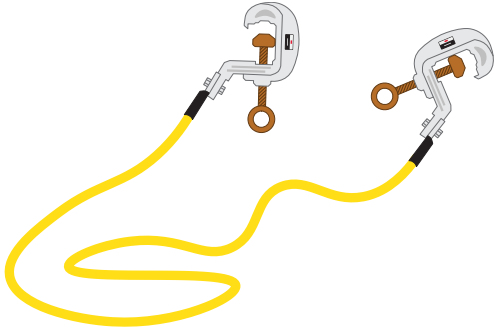

When bridging a crossover intersection, three bridging leads are required.

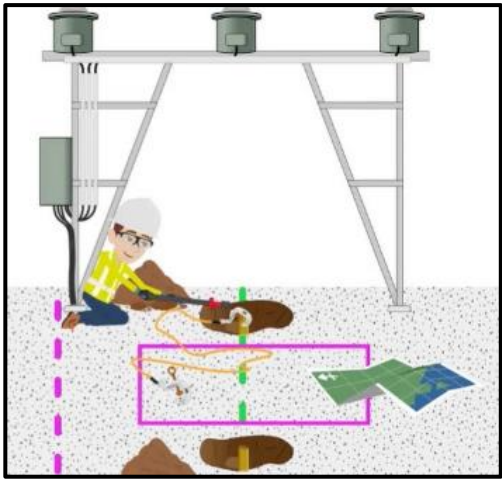
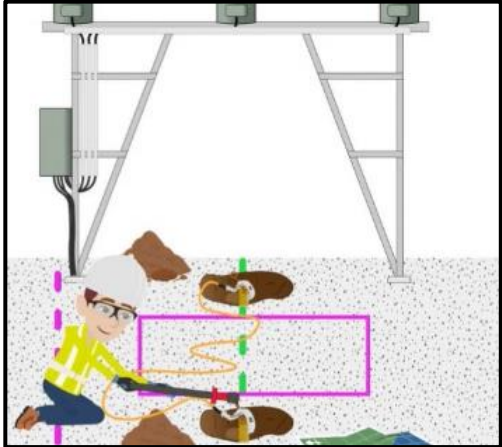
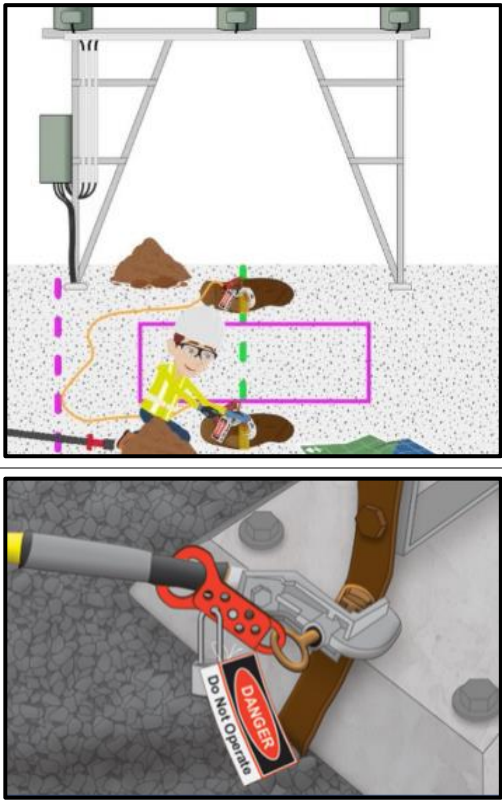
Hazard Assessment






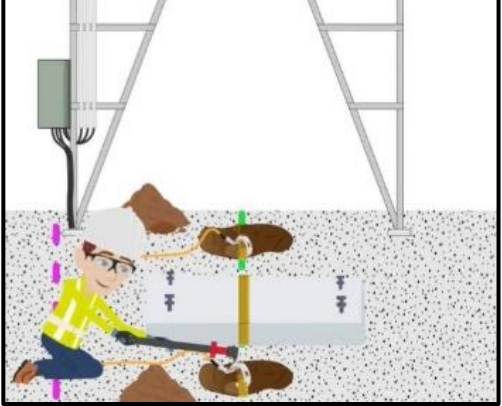
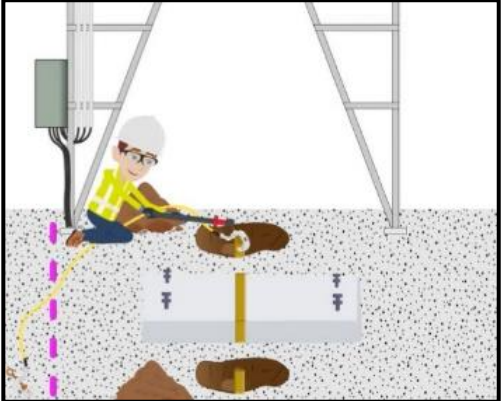
Safe Operating Process

Installing an earthing grid bridging lead

Job Steps	Hazards	Controls	
<p>Establish the earthing grid electrical path to be bridged & identify safe connection points for the bridging lead.</p>	<p>Hazardous voltages from broken or disconnected earthing grid.</p>	<p>Reference earth grid layout drawings etc; Visually confirm onsite; Ensure earthing grid is not bridged by contact with the body or other equipment.</p>	
<p>Obtain bridging lead.</p>	<p>Bridging lead not fit for purpose.</p>	<p>Use standard portable earthing lead with CATU MT-815S clamps: Confirm assembly, condition, and maintenance.</p>	
<p>Obtain bridging lead applicator.</p>	<p>Hazardous voltages.</p>	<p>Use approved application tools.</p>	

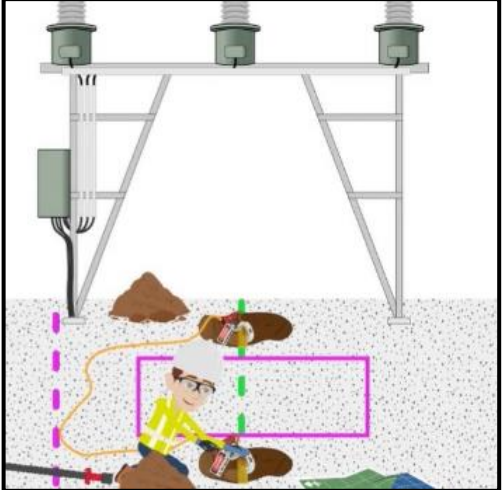
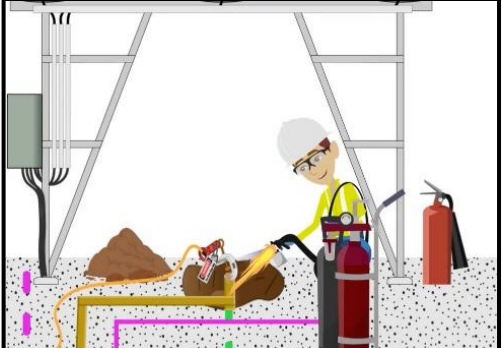
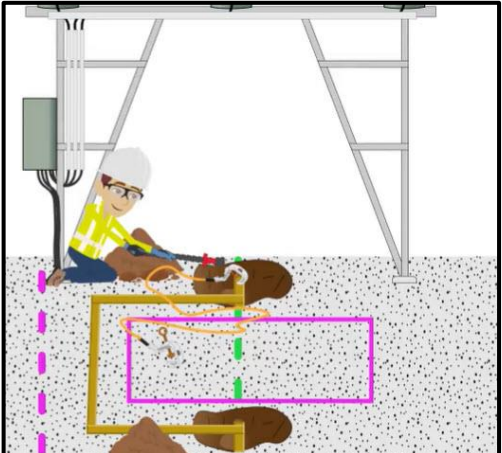
<p>Attach the bridging lead to the first point of connection.</p>	<p>Hazardous voltages.</p>	<p>Using applicator to keep hands and body clear of bridging lead clamps and earthing grid.</p>	
<p>Attach the bridging lead to the second point of connection.</p>	<p>Hazardous voltages.</p>	<p>Using applicator to keep hands and body clear of bridging lead clamps and earthing grid.</p>	
<p>Lock and tag.</p>	<p>Hazardous voltages caused by the removal of bridging lead prior to restoration of the earthing grid.</p>	<p>Apply O1 locks and Do Not Operate tags to each clamp of each bridging lead to explain its purpose.</p>	

Removing an earthing grid bridging lead

Job Steps	Hazards	Controls	
Confirm that it is safe to remove the bridging lead.	Hazardous voltages from broken or disconnected earthing grid.	Ensure the parallel connection is restored or another bridging lead is installed in parallel.	
Remove locks and Do Not Operate Tags from each bridging clamp.	Incorrect bridging lead removed.	Confirm the Do Not Operate tag description matches your understanding.	
Obtain bridging lead applicator.	Hazardous voltages.	Use approved application tools.	
Remove the bridging lead from the first point of disconnection.	Hazardous voltages.	Using applicator, keep hands and body clear of bridging lead clamps and earthing grid.	
Remove the bridging lead from the second point of disconnection.	Hazardous voltages.	Using applicator, keep hands and body clear of bridging lead clamps and earthing grid.	

Alternative bridging method using copper earth strip.

For bridging that will be required for extended periods, consider installing a welded bridge in parallel.

Job Steps	Hazards	Controls	
<p>Follow safe operating process for 'Installing an earthing grid bridging lead'.</p>	<p>Hazardous voltages. Damage to the bridging lead.</p>	<p>Ensure you plan ahead, allowing space around the intended welded connection so that the bridging lead will not get damaged from the heat.</p>	
<p>Clean the surfaces where the earth straps will be brazed together and weld the earth strap into place.</p>	<p>Sparks, heat generation. Connection integrity.</p>	<p>Ensure hot work processes followed. Confirm connections are made correctly and sufficiently to avoid disconnections in the earthing system.</p>	
<p>Remove bridging lead.</p>	<p>-</p>		



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