Engineering System Integrity
Electrical Network Safety Rules

Engineering Procedure
Electrical Distribution Unit

One Method of Safe Working

PR D 78102

Electrical Hazards and Warnings

Version 2.1
Date in Force: 1 February 2026

Transport Sydney Trains

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	29 July 2015	Wayne Halls	First issue as a Sydney Trains document, rebranded from previous RailCorp SMS-06-EN-0553 V1.3.
1.1	10 July 2018	Chris Leung	3 Yearly Review.
1.2	19 February 2019	Nick Loveday	Updated PR D 78102 "Approved by" to Associate Director Electrical Distribution Unit.
2.0	1 February 2022	ENSR Project Team	Reviewed as part of the ENSR Project. Incorporated section from SMS-06-GD-0268 V3.2.
2.1	1 February 2026	Deepak Sinha	Merged EA25-02 V1.1

Summary of changes from previous version

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Merged EA25-02 V1.1 New Section 5.1.4 Powered Tools 5.5.3 Excavation near cables 5.5.4 Work near cables in Ground Level Troughing (GLT) or (GST)	5
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1 Purpose and scope

To provide general warnings applicable to electrical work near or on/within electrical equipment and to describe a number of more common electrical hazards which may be encountered by Sydney Trains personnel, contractors and the public.

Persons undertaking work where these hazards are present shall ensure the highest practicable level of risk control is applied.

This procedure should be read in conjunction with, and in addition to, the procedure *PR D 78700 Working around Electrical Equipment*.

NOTE

PR D 78700 provides guidance on the risk assessment and planning process in relation to electrical hazards.

2 Definitions

Refer to the **Electrical Safety Definitions** page available on the **RailSafe** site.

3 Background

3.1 Possible consequences of electrical incidents

Contact with live electrical equipment poses serious risks, including:

a) Fatalities or cardiac arrest due to electric shock
b) Thermal burns from electrical currents or hot gases
c) Radiation burns and flash injuries affecting the eyes
d) Hearing damage caused by explosions or high-pressure discharges
e) Blunt force trauma resulting from falls or flying debris during electrical incidents

These injuries may occur directly through contact or indirectly due to secondary effects such as fire, falls, or mechanical forces.

For requirements on managing incidents where electricity is involved see Safe Work Instruction *SWI178 Response to Incidents involving Electricity*. Where a person is exposed to an electric shock follow *D2013/80869 Electric Shock Protocol.*

WARNING

Electric shock can be received without directly touching high-voltage wires. High voltage can cause the air around it to become ionised, creating a conductive path for electricity to jump to your body, resulting in a shock.

3.2 Electric shocks and the human body

The human body is a conductor of electricity, and severe injury or death may result if a conducting path that allows electric current to pass through the body is formed.

A conducting path can be formed by:

- touching or making contact with the exposed live electrical equipment with any portion of the body, whether intentionally or inadvertently, or
- bringing any portion of the body close enough to the exposed live electrical equipment for an arc to occur between the equipment and the body, or
- bringing close or touching the exposed electrical equipment with tools or materials that are not electrically insulated.

The danger of electric shock exists wherever a person could make contact between:

- live conductors, or
- a live conductor and earth, or
- 1500 Volt DC overhead wiring and rail, or
- different overhead wiring sections, or
- overhead wiring and earth, or
- overhead wiring structures and rail (or vehicles on rail).

In the event that a person receives an electric shock it is essential that appropriate first aid is provided without delay. Even if there are no immediate signs of injury the requirements of *D2013/80869 Electric Shock Protocol* must be complied with.

3.3 Electric Arcs

Serious injury can result from burns caused by electric arcs. Arcs can be caused by attempting to apply, though inadvertently in most cases, an earth or rail connection to live equipment, or by opening non-load breaking isolating switches carrying current.

Electric arcs may be the source of an explosion which will scatter molten material, radiate intense light and heat, and emit dangerous quantities of hot gas. Severe burns to the body due to radiated heat and contact with molten materials, and flash injuries to the eyes may result.

Burns may initially appear minor despite significant deep tissue injury. Burns are most often severe at the source (usually hands or head) and ground contact point (usually feet). The severity and extent of tissue damage are influenced by the strength and duration of contact with the source.

Burns from high voltage may appear minor at the surface whilst causing significant damage to underlying deeper tissue. Skin with high resistance will transmit energy to deeper tissues with lower resistance.

Severe tissue burns can result in kidney failure. Low voltage burns look like ordinary thermal burns.

Arcs may also cause a compressed air shock wave which can damage ear drums and create permanent hearing loss.

3.4 Explosion

The electrical energy available through a fault on an electrical power system, particularly an underground cable system, can be substantial. In Sydney Trains, DCCBs are designed to withstand a short-duration prospective fault current of 75 kA. This represents an enormous amount of energy, particularly if the fault is not cleared within a very short time duration.

The destructive potential of the resulting rapidly expanding hot gas, and the other solid material which it may propel, shall not be underestimated.

Under fault conditions, extreme electro-magnetic forces can also have unexpected and destructive consequences.

4 Preventive Controls against Electric Arcs, Electric Shocks and Explosions

Preventive controls against the occurrence of electric arcs and explosions include, but not limited to, the following:

- Never operate off-load isolating switches on load.
- Follow the correct procedure when undertaking operating work, (e.g. prove dead at every location immediately prior to the application of earths or rail connections).
- Wear the appropriate PPE when undertaking switching operations, live work, or other work within substations. (Refer to *D2013-80874 PPE for Electrical Work*)
- Work under Electrical Permit conditions unless not practicable to do so. (Refer to PR D 78700 Section 11 Work near electrical equipment)
- Where work is carried out on energised equipment, appropriately Authorised Persons undertaking such work, as described in procedure PR D 78701, shall strictly adhere to the appropriate Safe Work Method Statements, including the correct use of insulated tools.
- Work is assessed, planned, managed, supervised and conducted in accordance with the:
  - *RL D 79800 Electrical Network Safety Rules*
  - *PR D 78700 Working around Electrical Equipment*
  - all documents referenced by the preceding two documents.

5 Particular electrical hazards

5.1 Work activities and tools

5.1.1 Hazardous materials, tools and equipment

Unless there is definite knowledge to the contrary, treat all materials including liquids, gases, metal, tree branches, clothing, ropes, and flames as conductors of electricity.

Unless there is definite knowledge that the item concerned is suitable, approved and maintained in accordance with the SMS and manufacturers' requirements, for use at the voltage concerned, treat all tools and equipment as capable of conducting electricity.

Long objects, particularly metal objects, can be a hazard if not handled with care and Safe Approach Distance from exposed live electrical equipment maintained. Such objects include but are not limited to:

- brooms
- ladders
- long tools
- scaffolding or temporary structures
- lengths of metallic pipe, conduit and reinforcing bars
- portable radio equipment with long or telescopic aerials
- metallic guttering, metal roof or wall sheeting
- rope, hose and wire
- tree branches
- metal rulers/tape measures.

Take care to make sure that long objects are neither placed nor used in positions where they are likely to fall onto, come in contact with, or be blown across, exposed live equipment.

5.1.2 Clothing and Personal Items

Jewellery or other items such as metallic watches, bracelets, rings, neck chains, or body piercings, exposed zips or spectacle frames can be hazardous. Such items may be caught on protruding objects or rotating machinery. Metallic items also conduct electricity and will therefore increase the severity of accidental contact with live electrical equipment as they make good contact with the human body.

5.1.3 Flames near electrical equipment

Flame is a good conductor of electricity and care is to be exercised when using flame-producing items near electrical equipment. Under certain circumstances, open flame torches and welding torches can throw a long stream of flame.

Flames near live exposed equipment can cause an arc to form along the path of the flame if a tongue of flame or vapour makes contact with the exposed equipment. To minimise the risk of injury maintain the Safe Approach Distance between the flame and exposed live electrical equipment.

5.1.4 Powered tools

Electrically powered tools in the electrified rail corridor shall be either:

a) battery powered

b) supplied via an isolation transformer

c) double insulated.

5.1.5 Metallic tapes

WARNING

When working around electrical equipment, use only non-conductive tapes and sticks that have been electrically tested, approved and branded.

Safety Alert *D2021/24973 Hazards presented by conductive metallic tapes*, state that metallic tape are not allowed within 6m of track.

Conductive tape measures shall not be used within the electrified rail network. Use nonconductive tapes, or non-contact measuring tools such as laser rangefinders. Steel tapes, metal reinforced linen tapes and steel rulers can be very dangerous as they conduct electricity and are **not** to be used:

- when taking measurements near live exposed electrical equipment, or
- when there is any likelihood that the metal tape/rule might bridge between metal objects that might be at different potentials, for example:
  - between overhead wiring structures and rail (or vehicles on rail)
  - between structures and fencing or metallic troughing
  - across gaps or breaks in the rail.

More examples are listed in Section 3.2 Electric shocks and the human body of this document.

Refer to instruction SWI15 Inspection and Testing of Insulated Sticks, Tools and Equipment used for work On, Near or In the Vicinity of Exposed 1500 V dc OHW or Equipment for the inspection and test requirements of non-conductive measuring tapes to be used around electrical equipment.

Measuring equipment with a maximum dimension exceeding 1.2m – including but not limited to track gauges and survey staffs - shall be non-conductive. Work involving such equipment near live electrical apparatus shall adhere to the approved SWMS or Safe Work Instruction (SWI).

5.1.6 Handling objects over 1m in length in the vicinity of electrical equipment

Long objects, especially conductive objects such as lengths of guttering, roof sheeting and scaffolding tubes present special risks and must be handled carefully in the vicinity of electrical equipment.

Long objects, particularly metal ones, can be hazardous if not handled with care or kept away from exposed live electrical equipment. Such objects include, but are not limited to: -

a) Telescopic tools & equipment

b) Brooms

c) Ladders, including metal reinforced

d) Tools longer than 1.2m in any dimension

e) Scaffolding or temporary structures

f) Lengths of metallic pipe, conduit, and reinforcing bars

g) Portable radio equipment with long or telescopic aerials

h) Metallic pipes, guttering, roofing, or wall sheeting

i) Rope, hose, and wire

j) Tree branches, particularly when wet

In normal circumstances the minimum SADs in *SP D 79049 Safe Approach Distances (SADs)* Table 1 Minimum SADs to exposed electrical equipment for persons and tools they hold, may be applied safely when two people carry below shoulder height, any long object from opposite ends and control of movement can be absolutely maintained for the duration of the task. (Refer to **Figure 1**)

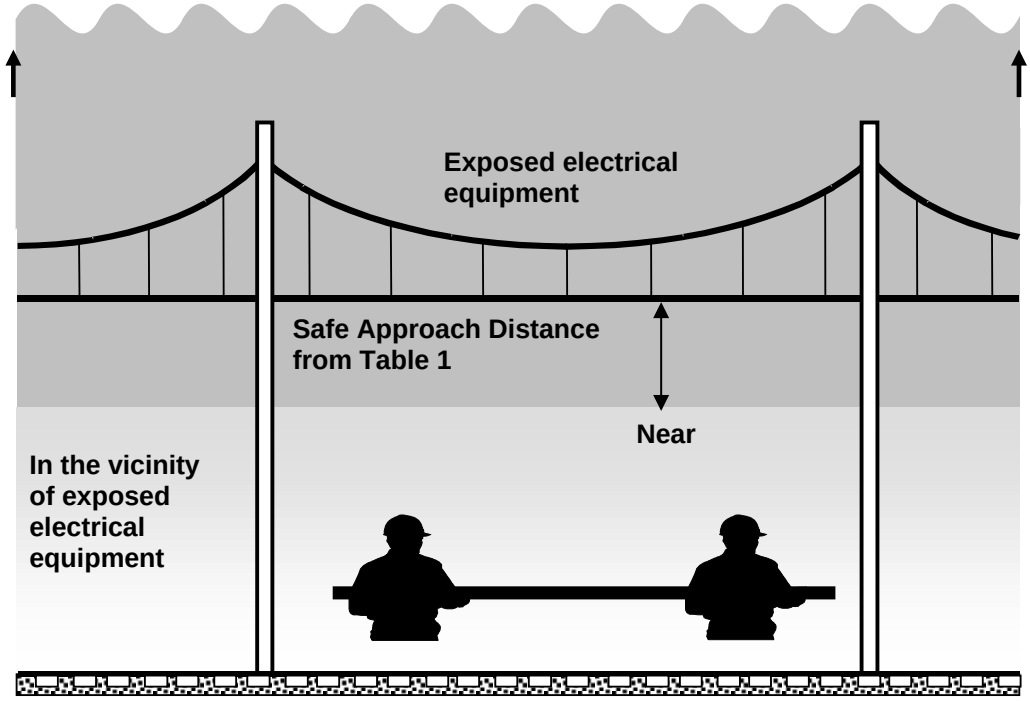

Figure 1: Handling objects over 1 metre in length in the vicinity of electrical equipment (two people)

When handling a long object, the SAD shall be increased to the **minimum SAD in SP D 79049 Table 1 plus half the length of the object**, to ensure the object does not strike exposed electrical equipment. For example, if the SAD was 1.5m and the object was 6m long then at least 3m is to be added to give a SAD of 4.5m. (Refer to **Figure 2**). In addition: -

a) When handling objects longer than 2 metres, safe handling practices shall be considered

b) Metallic objects longer than 1.2 metres, capable of bridging two rails, are not permitted in the rail corridor unless they are covered with an insulated surface

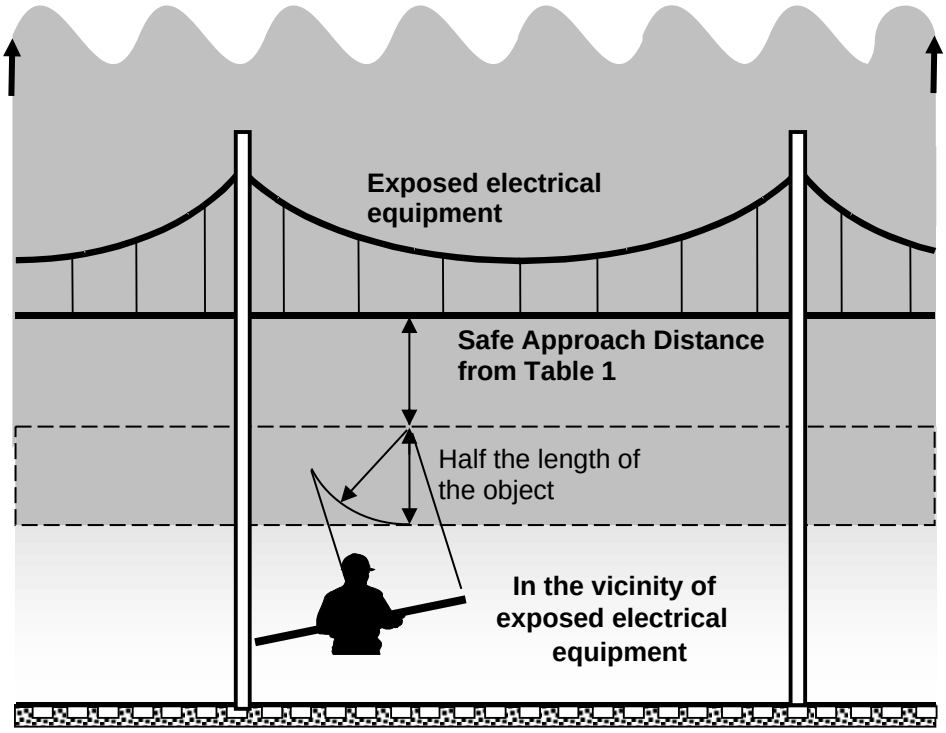

Figure 2: Handling objects over 1 metre in length in the vicinity of electrical equipment (one person)

NOTE

For work above exposed electrical equipment, refer to Section 9 Work above exposed electrical equipment

In all cases, the Line Manager shall:

- assess the site or weather conditions that might reduce the control of the object while working in the vicinity of electrical equipment, and
- assess the suitability of removing the supply for the electrical equipment or implement adequate additional protection or controls.

5.2 Cranes, vehicles and plant

When looking up at conductors it is often difficult to judge the minimum SADs. Where possible, view the situation from several angles to make sure that the required minimum Safe Approach Distance is not infringed.

Take particular care when using cranes, vehicles or plant fitted with elevating units or tipping trays and items such as extendable lighting masts in the vicinity of electrical equipment.

Further, Line Managers shall note the magnification of movement that occurs with tall items of equipment on relatively narrow bases. Any movement due to uneven ground, subsidence, or similar may be magnified several times in the resultant movement at the top of the item. For more information regarding these hazards refer to *SP D 79050 Safe Use of Mobile Plant around Electrical Equipment*.

Such plant and equipment include but are not limited to:

- cranes, elevating work platforms
- mobile temporary structures/scaffolding and scaffold tubes carried by hand.

NOTE

There are specific requirements for the safe use of mobile plant in the vicinity of electrical equipment. Refer to SP D 79050.

5.3 Activities altering ground level under aerial conductors

The following activities carried out under or in the vicinity of aerial conductors might result in the statutory clearances of aerial conductors from ground not being maintained and shall not occur without prior approval of the territory electrical engineer: -

- Stockpiles or stacks of materials or spoil,
- Parking large plant and machinery,
- Site facilities including containers, temporary buildings, sheds, toilets,
- Filling-up ground, or
- Earthworks or landscaping using machinery, especially for those that will result in changes in ground level, altering the clearance to aerial lines or disturbing the ground in the vicinity of a pole base.

NOTE

There are specific requirements for activities around powerlines

Refer to https://www.transport.nsw.gov.au/sydneytrains/community/power-lines and SP D 79035 Sydney Trains Electricity Distribution Network Management Plan.

Completion of work could create a hazard, even if the work itself does not infringe the required minimum SAD for persons, tools, mobile plant, or scaffolding/temporary structures, resulting in reduced conductor clearances from the ground and structures. This could pose risks to people working under the aerial line.

Altering ground levels near aerial line poles can result in structural failure of the pole—either immediately or over an extended period. Refer to the *Guideline for the Management of Activities within Electricity Easements and Close to Electricity Infrastructure ISSC-20* for guidance.

5.4 Fallen wires

WARNING

All persons are to protect themselves and others from the danger of making contact with or approaching fallen aerial conductors or objects that are in contact with fallen conductors.

Treat all such wires and objects as live until the required Electrical Permit has been issued.

Although a contact or catenary wire might have fallen to the rails and potentially caused a short circuit, this does not mean that the 1500 Volt supply has been isolated and made safe. On the contrary, the supply may be switched onto the overhead wiring at intervals.

Supply will be removed from the damaged and adjacent sections to reduce the electrical danger at the site only once ICON Electrical has been informed about the fallen overhead wiring. Do **not** consider the area safe until a Rescue Power Outage (RPO) is instigated or Electrical Permit has been received.

NOTE

8m clearance is required until the relevant permit is issued.

When approaching a derailment or collision, treat vehicles at 1500 Volt potential as they may be in contact with overhead wiring. Separation of the vehicle from the rails could cause the vehicle to be live at 1500 Volt.

Refer :- *SWI178 Response to Incidents involving Electricity*.

5.5 Concealed cables

5.5.1 Concealed cables in building and structures

Line Managers shall check for the presence of concealed cables in buildings and structures before starting work such as cutting or drilling or demolishing walls or building structures:

a) Near low-voltage installation cables at stations, workshops, or depots shall be carried out in accordance with facility asset managers' requirements.

b) Near high-voltage or low-voltage distribution cables or 1500 V dc rail traction cables shall be carried out in accordance with the Regional Electrical Engineer's requirements.

Where it is not possible to positively determine that there are no cables in the way before work commences, the Line Manager shall seek the advice from the Electrical Engineering Manager. The Electrical Engineering Manager may require specific procedures to be followed. Work is not to start until the situation has been investigated and advice has been received.

5.5.2 Underground cables and buried services

WARNING

Underground cables and other services are owned by Transport Asset Manager of New South Wales (TAM) and by other authorities or organisations. Confirm the locations of all services before work involving digging, excavating, boring, piling, installing fence posts, or driving electrodes is begun.

All excavation and earthworks shall be carried out in accordance with *SMS-06-OP-3026 Work Health and Safety (WHS) Risk Management* and *SP D 79052 Cables – Work near or on/within* Section 4 Excavation and earth works near or on/within of cables.

Underground services exist within the rail corridor, adjoining rail property, public streets, public property, and within private property. The presence of power poles and aerial conductors shall not be taken as an indication that there are no buried services in the area. Prior to the commencement of any excavation work or earthwork, an underground services search must be undertaken.

For all excavations Notify **Before You Dig Australia (BYDA)** for any digging or excavation exceeding 30 cm below ground level:

a) Outside Rail Corridor: Visit **BEFORE YOU DIG Australia**.

b) Within Rail Corridor: Visit **BEFORE YOU DIG Australia** and **Detailed Site Survey (DSS),** Request a DSS using *SMS-06-FM-4384 Services Search Request form* is to be completed and sent to Services.Request@transport.nsw.gov.au. For advice and information, contact the Underground Asset Manager.

The Line Manager shall ensure all service searches are initiated and maintain the documents obtained.

The person in charge of the work shall ensure that work does not begin until the services search has been completed. Work may only commence after all of the following have been completed:

a) All searches have been completed, and the relevant documentation obtained.

b) The relevant Network Maintenance **Regional Electrical Engineer** has been consulted for requirements when working with 3 metres of the expected location of Sydney Trains electrical cables.

c) A SWMS has been developed and approved following relevant guides (e.g., *General Guide For Working In The Vicinity Of Overhead And Underground Electric Lines* and *Work Near Underground Assets – Guide*). Safe work methods must be approved and communicated to the workforce.

d) Risks such as hazards, damage to cables, exposed or unsupported cables, and trench collapses, have been identified and safety controls implemented,

e) The work is supervised by a certified Safety Observer with recognised industry qualifications.

If an excavation will be within 3 metres of the expected position of Sydney Trains cables,

a) A cable locator shall be used to confirm the location of cable (Consult with Signal Engineer for appropriate cable locator, as some locator systems can interfere with signal equipment)

b) Prior to work commencing call ICON Electrical and inform them of your activity, and

c) Before leaving the site notify ICON Electrical that the work party has left.

NOTE: The maps received from a BYDA request are only accurate for 28 days from issue. A new request shall be made after the expiry period. **If a service search (BYDA / DSS) is not obtained, digging shall not commence.**

5.5.3 Excavations near cables

The type of excavation methodology employed near Sydney Trains cables or conduits will depend on the nominal voltage of the cable and the separation distance of the planned activity from the Sydney Trains cables or conduits.

The person in charge of the work shall assess the risk of electric shock to the workers, arising from damage to cable insulation, and implement appropriate controls.

Any excavation work which causes the cables or conduits to be unsupported for a distance greater than 1m shall require an engineered cable support design accepted by Sydney Trains ESI-Electrical Engineering.

Hand excavation methods shall not cause damage to any Sydney Trains cable or conduit.

The Network Maintenance Regional Electrical Engineer shall be contacted if excavation or boring is proposed within 3 metres of Sydney Trains (HV or LV) distribution or Rail Traction cables, or if there are any visual indicators that may alert to the presence of underground cables. The Regional Electrical Engineer's acceptance of the proposed work method is required prior to commencing excavation or boring within 3 metres of the expected position of cables.

5.5.4 Work near cables in Ground Level Troughing (GLT) or Galvanised Steel Troughing (GST).

Before any activities within 3 metres that have the potential to strike or damage GST or GLT the Line Manager shall conduct a services search to identify the services within. These may include HV, LV, signalling or communications cable. Configuration change processes apply for any changes to the cable system.

Care should be taken to identify and protect the location of electrical cable troughing, and cables installed on peg lines. Controls shall be implemented to mitigate damage though work methods and plant movements or vehicle impact during works. GLT has a maximum load rating, which shall not be exceeded, and shall be protected for any plant activity operating around the GLT.

6 Traction system

6.1 1500 Volt DC Overhead Wiring structures or Equipment

There is a possibility that overhead wiring structures may rise to an electrical potential above earth. The risk of persons receiving an electric shock when standing beside an overhead wiring structure and touching the structure, or when standing on the rail, is low but not impossible.

Creating a path between and OHW structure to rail or earth via body or a tool may lead to an electric shock.

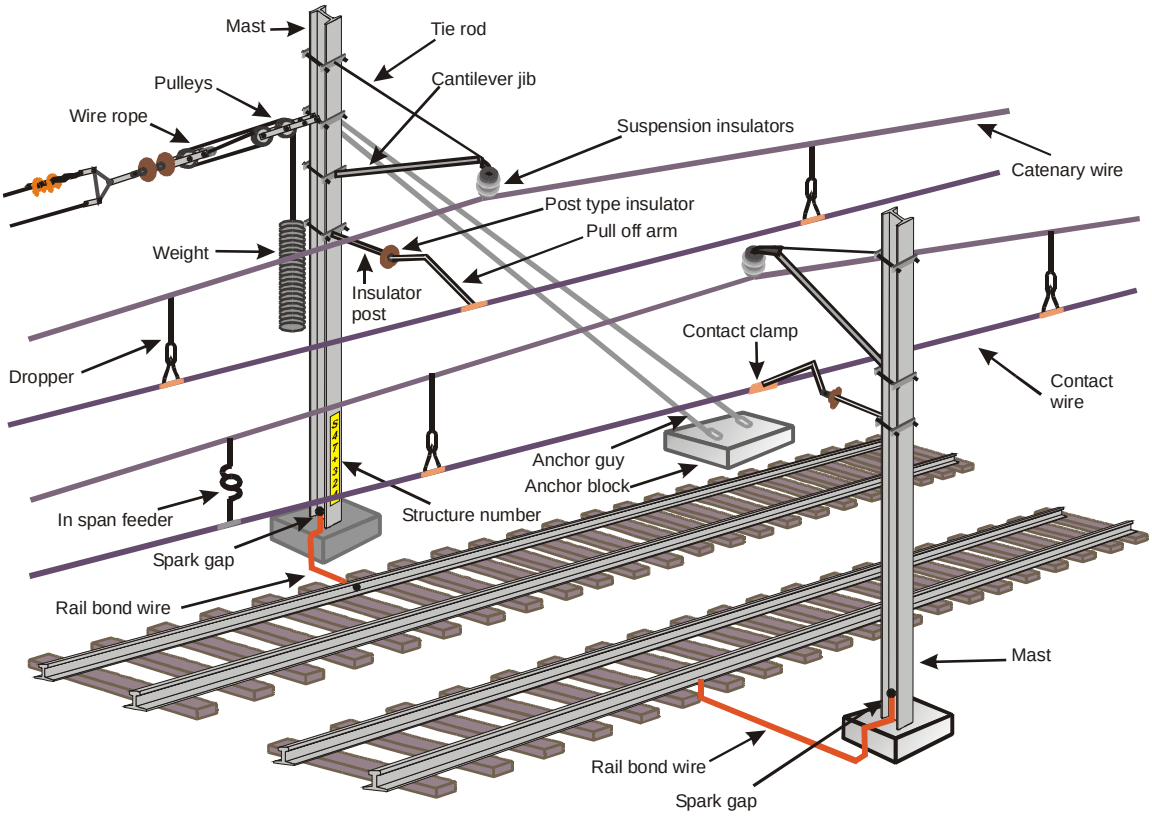

Figure 3 - OHW structures and associated equipment

Where practical, plan work to ensure that a person cannot contact BOTH a structure that is supporting energised OHW and either:

- An earthed object (e.g. bridge portal, scaffold, fence, handrail, lift, galvanised steel trough, lighting pole or support, etc.), or
- Rail, or
- Rail-connected OHW (e.g. during an OHW inspection), or
- A rail-connected vehicle.

Note: Authorised Signal Personal shall follow signalling procedures for Spark Gap cables and shall wear appropriate PPE for the task.

If the work cannot avoid contact between OHW structures and any of the items listed above, and the work cannot be performed with an Electrical Permit to Work, then arrange for an Authorised Traction Line worker to prove the OHW structure is safe to touch or confirm the structure is bonded to rail via a spark gap to verify the work can be undertaken safely.

Arrange for an electrically authorised person to test that the structures are not live (refer to *PR D 78306 1500 Volt DC Overhead Wiring Structure to Rail Voltage Test*), if there is a risk of persons touching overhead wiring structures at the same time as touching steel troughing, metal fences, rolling stock or standing on the rail.

Engineering approval is required to install equipment on OHW structures.

WARNING

When working near or on/within 1500 Volt DC OHW structures, rail or rail connected equipment, (including trains standing on the rails), substations and sectioning huts, only use electric power tools that are:

- **battery operated**
- **supplied from an isolating transformer, generator or inverter.**

Workers should refrain from touching OHW structures with live 1500 V d.c. overhead wiring without:

a) Wearing Personal Protective Equipment (PPE) appropriate for their task, including work gloves (either leather or nitrile-coated palms) and non-conductive footwear;

b) Undertaking a visual inspection for broken insulators attached to the structure (see circled items above) or other signs of electrical faults prior to touching the structure.

6.2 Interfering with negative connections to rail

If the negative cables connecting a substation or sectioning hut to the track or to the track bonding equipment are broken or disconnected, equipment in the substation or sectioning hut could cause the cable voltage to rise to a dangerous level. Similarly, separating a section of rail to which these negative cables are connected from the rest of the track could cause the separated rail to become live at a dangerous voltage. Refer to responsible Signal Engineer for advice.

Where the trackside negative connection will be removed, consult the signalling discipline and Regional Electrical Engineer.

Report broken or disconnected cables to ICON Electrical on telephone no. (02) 9379 4911.

Line Managers are to coordinate any work requiring disconnection of negative return cables to substations/section huts, such as re-railing, with the relevant Electrical Engineer. Appropriate bridging connections are to be made when negative cables are connected or disconnected, the 1500 Volt supply is to be removed and the persons involved signed on to the appropriate Electrical Permit.

6.3 Disconnecting or removing sections of rail

When removing or disconnecting sections of rail, make allowance for traction return current in accordance with *Sydney Trains Signalling and Control System Procedures*. This current may be the result of electric traffic on an adjacent track or may be current returning to a nearby substation from more distant electric traffic on the same track.

Where the traction return rail will be cut, or trackside negative connection will be removed consult the signalling discipline and the Regional Electrical Engineer.

When a traction rail or traction bonds are disconnected in a section of electrified track beyond which there is no substation (e.g. Port Kembla North to Port Kembla), there is a danger that overhead wiring equipment or equipment on a stationary train might cause the rail ends to become live at a dangerous voltage. For advice regarding this issue, contact the relevant region electrical and signalling representatives.

If it is necessary to remove the 1500 Volt supply to make the work safe, an Electrical Permit is to be issued to make sure that supply is not restored until the rails or traction bonds are reconnected.

For further information refer to *PR S 40026 Rerailing – Precautions to be taken* and *PR S 40027 Traction Return (1500V DC)*.

NOTE

Removing the 1500 Volt supply will not remove the risk of voltage potentials on either side of a gap in the rail.

6.4 Working around portable rail connecting equipment

WARNING

Do not interfere with or remove the connection to rail of portable rail-connecting equipment without the proper authority.

A person breaking the connection of portable rail connection equipment to rail could inadvertently become part of the 1500 Volt circuit, potentially exposing themselves to an electrical hazard and could also render the rail connection ineffective in protecting other workers.

Therefore, all persons are to make sure that the connection to rail of portable rail connecting equipment is not damaged or disconnected. Contact ICON Electrical immediately if accidental damage or disconnection occurs. ICON Electrical will make arrangements with electrical staff if it is necessary for a portable rail connection to be relocated for work to proceed.

7 Earthing system

7.1 Disconnected or broken earth connections

Earth connections between equipment and the earthing system shall not be removed while the equipment is in service unless a suitable alternative earth connection is provided first.

WARNING

If an earth or neutral connection is broken or removed from equipment that is in service, a dangerous voltage may appear on the neutral or earth cable connected to that equipment.

Equipment that can produce dangerous voltages under these conditions includes voltage transformers and surge arresters.

7.2 Substation earth grid voltages and transferred earth potentials

Under fault conditions, substation earth grids can rise to high voltages.

Care shall be taken when working on power cables, metallic telecommunications cables and HV aerial lines into substations. Dangerous voltages could arise between the earth grid and the cable or HV aerial line conductors (including the cable sheath and HV aerial earth) if a substation fault or a remote earth fault occurs during the work.

Appropriate bridging connections shall be made between the equipment being worked on and the substation earth grid.

7.3 Earth grid and earth electrodes

If part of an earthing system is separated, a voltage may appear at the break. When it is necessary to break a part of any earthing system and there is no parallel connection, bridges of equivalent current carrying capacity shall be connected across the part of the earthing system before it is broken, unless all associated equipment has been isolated.

WARNING

Particular care shall be taken when reconnecting a broken earth lead.

7.4 Check to ensure no missing earthing connections before touching

Incidents of copper theft and other vandalism acts create safety hazards.

To avoid possible electric shock, it is essential that all people gaining access to or working inside substations shall check to ensure that there are no missing earthing connections at substation access gates, fencing and switch operating handles etc. prior to touching such items or undertaking switching operations.

The photographs below show where earthing conductors have been stolen from a substation structure and a switch down rod.

8 Neutral, negative and earth circuits

When working on the neutral, negative or earth circuits, using a voltage tester is not sufficient to establish safe conditions. It is necessary to make sure that no current is flowing as breaking a neutral, negative, or earth connection that is carrying current will result in line voltage appearing across the break.

If a tong tester is available, this could be used to prove that no current is flowing, remembering that on DC equipment a DC tong meter would be needed.

Also note that in the case of the negative for a harmonic filter, while it is in the dc negative circuit, the current through the harmonic filter is audio frequency AC, not DC or mains frequency AC, and care shall be taken to make sure an appropriate instrument is used.

When working on the neutral or negative circuits, other precautions include:

- Checking that the number of connections is what is expected - additional unexpected connections shall be investigated before work proceeds.
- Checking any labels on all conductors connected to a bar or link, not just labels on the conductors being worked on.

9 Rectifier negative

While the rectifier negative circuit is normally near to rail potential, in the event of a fault causing a DCCB opening, high voltages can appear across the reactor and therefore between the rectifier negative and rail.

WARNING

Closing the rail earth contactor (REC) does not reduce the risk of shock from the rectifier negative.

Refer to *PR D 78304 Work on 1500 Volt Negative Equipment Inside Substations* for more details.

10 Capacitors

Capacitors store electrical energy and care shall be taken when working on equipment with capacitors. Large capacitors or banks of capacitors shall be:

- isolated, and then
- discharged through an appropriately rated load or allowed to naturally discharge over an appropriate time frame, and then
- proved dead prior to commencement of work.

WARNING

Ensure that capacitors are isolated, completely discharged (for at least 5 minutes) and “Tested before Touched” prior to working on the equipment.

Capacitors are found in rectifiers, harmonic filters, lighting control equipment and other places. Lengths of screened or metallic sheathed cable also have significant capacitance and shall be treated in the same manner.

11 Battery rooms

On routine inspection and maintenance work, where quantities of electrolyte are handled, a face shield or goggles shall be worn. In addition, when the electrolyte is in liquid form, a dust coat should also be worn. These personal protective equipment (PPE) requirements are in addition to clothing, footwear and other PPE as per PR D 78700.

Unprotected hands and clothing shall be kept away from battery cells at all times.

Work performed on a battery in service shall use methods which preclude circuit interruption or arcing in the vicinity of the battery.

The handles of all tools shall be insulated and step ladders shall be non-metallic. Test equipment leads shall be firmly connected with sufficient length of cable to prevent accidental arcing in the vicinity of the battery. All connections to load test equipment shall include short-circuit protection.

Due to the risk of igniting explosive gases, smoking, the operation of electric hand tools, the use of open flame and the operation of equipment that produces electric arcs **is prohibited** in the immediate vicinity of the battery.

Any spilled electrolyte shall be diluted or neutralised immediately and removed.

If electrolyte splashes in the eye or on the skin, the aim of the treatment is to dilute and eliminate the acid or alkali by flooding the eye or skin immediately with water. Following irrigation of the eye or skin, immediate medical attention shall be sought.

12 Current transformers

The secondary circuit of a current transformer (CT) shall not be open-circuited or left open circuit while the primary circuit is live. Care shall be taken when working on substation wiring, especially protection relays and CT links in circuit breakers.

13 Work on or above and roof equipment of electric vehicles

13.1 Work on or above electric vehicles

An Electrical Permit to Work (refer to *PR D 78501 Electrical Permit to Work*) shall not be issued for work on or above the roof of an electric locomotive or electric vehicle (irrespective of the vehicle being a 4 car or 8 car set) if there is live overhead wiring above the vehicle or any pantograph, regardless of that pantograph being lowered and/or isolated.

13.2 Securing of damaged pantographs

Care shall be taken when it is necessary to secure or make safe a damaged pantograph of an electric rail vehicle. Due to the vehicle design, even if one pantograph is lowered from the overhead wiring, it may still be live as it may be electrically connected to the other pantograph which is raised and in contact with the overhead wiring.

The owner and maintainer shall confirm that the pantograph has been isolated prior to testing dead and commencing work to secure or make safe the damaged pantograph.

If a damaged pantograph is tied down and it is within 50mm of the roof, the pantograph isolating switch shall be opened and all other electrically connected pantographs shall be lowered and the associated air supplies isolated.

13.3 Roof mounted capacitors

Roof-mounted capacitors of electric vehicles shall be treated as being live unless isolated, discharged and proven dead - refer to the “Warning” of Section 10 of this document.

14 Precautions to be undertaken when lightning is imminent

Refer to Figure 3 below for the appropriate precautions to be undertaken when working outdoors and lightning is imminent.

If it is essential to work on the OHW at a time when there is an increased risk due to lightning, all conductors and metallic parts at the worksite shall be bonded together. Under such circumstances, if working on the OHW at a:

- structure, the OHW shall be connected to rail and to that structure, or
- mid-track insulator, both sides of the mid-track insulator shall be bonded together and connected to rail.

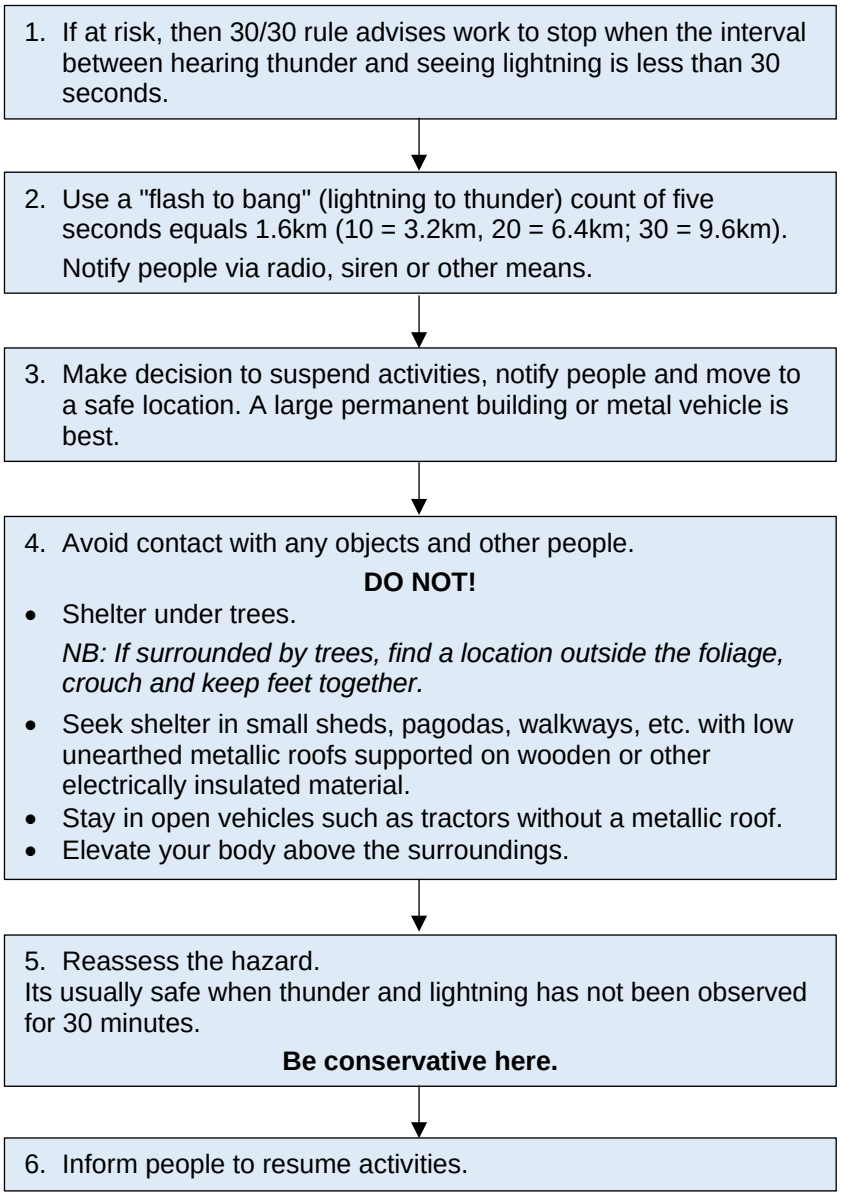

Figure 4: Stay away from lightning using the 30/30 rule. Refer to *AS 1768:2021 Lightning Protection* for additional information.

15 'Danger Do Not Operate' tags (DANGER Tags)

'Danger Do Not Operate' tags (DANGER Tags) serve as a warning that the electrical equipment to which they are attached shall not be operated. DANGER Tags are placed for the safety of persons. Refer to *PR D 78104 Securing Systems for Electrical Equipment* on the correct procedure for using DANGER Tags on electrical equipment.

WARNING

DANGER Tags shall not be interfered with or removed without the proper authority.

16 Warning signs and protective measures

Appropriate permanent or temporary work area markers, safety fences, demarcation taping, warning signs, barriers, guards, plates, warning lights and other protective devices, shall be used as required where hazards exist to employees, contractors or the public as appropriate for the works being undertaken.

NOTE

Particular requirements for demarcation taping of Electrically Safe Work Areas within substations are contained within *PR D 78506 Substation – Demarcation Taping*.

17 Reference documents

AS 1768:2021 Lightning Protection

D2013/80869 Electric Shock Protocol.

SWI115 Inspection and Testing of Insulated Sticks, Tools and Equipment used for work On or Near Exposed 1500V OHW or Equipment

PR D 78104 Securing Systems for Electrical Equipment

PR D 78304 Work on 1500 Volt Negative Equipment Inside Substations

PR D 78306 1500 Volt DC Overhead Wiring Structure to Rail Voltage Test

PR D 78501 Electrical Permit to Work

PR D 78506 Substation – Demarcation Taping

PR D 78700 Working around Electrical Equipment

PR D 78701 Personnel Certifications – Electrical

PR S 40026 Rerailing – Precautions to be taken

PR S 40027 Traction Return (1500V DC)

RL D 79800 Electrical Network Safety Rules

SMS-06-FM-4384 Services Search Request form

SMS-06-OP-3026 Work Health and Safety (WHS) Risk Management

SP D 79049 Safe Approach Distances (SADs)

SP D 79050 Safe Use of Mobile Plant around Electrical Equipment

SP D 79052 Cables – Work near or on/within

SWI178 Response to Incidents involving Electricity.

D2013-80874 PPE for Electrical Work

General Guide For Working In The Vicinity Of Overhead And Underground Electric Lines and Work Near Underground Assets – Guide).