VULCAN MINE

Mine Operating Procedure

Cable Management

1. PURPOSE

The purpose of this document is to define the requirements for the use, care and maintenance of high voltage electrical trailing cables and to establish standards and guidelines for controlling the risks involved. In particular this document has the aim to:

a) Reduce the frequency of personal injury and cable damage.
b) Reduce the costs associated with high voltage trailing cables and associated failures.
c) Ensure procedures are practical, safe and efficient.
d) Provide guidance on Investigating and outcomes for cable incidents. e Provide guidelines for storage.

2. SCOPE

This standard must apply to all persons involved in the use, care and maintenance of high voltage electrical trailing cables.

3. DEFINITIONS

Must	To be understood as mandatory.
Should	To be understood as non-mandatory, advising, or recommended.
Authorised	Authorised in writing by the SSE or authorised delegate.
Cable boat	A skid mounted stand with an arch on one side (for vehicle access) and hooks at both ends.
Cable plug stand	A non-mobile stand which supports cable coupling points above ground level.
Cable plug skid / torpedo	Similar to the Cable Plug Stand, but on a skid base, allowing the skid to be towed without the need for power being isolated.
Cable support tower	A skid mounted stand that supports the cable over a roadway. These are used in pairs for cable haul road crossings and should not be relocated with cable in the air.
Competent person	A person who has through experience and learning acquired the skills and knowledge necessary to conduct a specified task.
Submerged cable	Fully immersed in a body of liquid for a distance of 3m+
Manhandle	Physically grip with your hands
Maximum Tension	The maximum tension is set by the Electrical Engineering Manager (EEM) and includes consideration of the terrain and the site towing equipment power. The manufacturers recommended safe working tension in Newtons.
Maximum Trailing Distance	Maximum distance in metres that a cable may be trailed calculated and determined by maximum tension permitted to be generated in the cable and the consideration as above.
Mechanical Handling	Use of a mechanical aid to move or adjust
Spotter	CMW trained in this cable management standard
Tail	The length of trailing cable directly connected to the Highwall miner

4. STANDARDS, CODES AND REGULATIONS

All mine workers required to work under this mine operating procedure will ensure that they have read and fully understand the requirements before proceeding.

All design and deliverables produced must comply with the requirements of the Acts, Regulations, Rules, By Laws and other requirements of the Australian and Queensland Governments, local governments and other statutory authorities.

All methods, procedures, components and equipment must comply with the latest revision of the relevant Australian Standards or in the absence of appropriate Australian Standards with relevant IEC, IEEE, EN or ISO Standards, together with the requirements of competent authorities having jurisdiction over all or part of the manufacture, installation or operation of the equipment, except where modified by this specification

5. TRAILING CABLE OVERVIEW

General

Trailing cables transmit electricity from substations to electrically powered equipment such as draglines, electric shovels, and auxiliary substations.

Electrical Energy

At Vulcan Mine, high voltage is supplied via 3 x 415V generators through a 415V to 6.6kV substation which supplies the Highwall miner.

Features of Trailing Cable

a) Sheath: Protects electrical components from impacts and contaminants.
b) Earth Conductors/Screens: Provides safety in case of insulation failure.
c) Insulation: Heat-resistant rubber (approx. 5mm thick).
d) Power Conductor: Made of annealed copper for energy transmission.
e) Pilot Conductor: Acts as a safety mechanism, tripping power if severed.

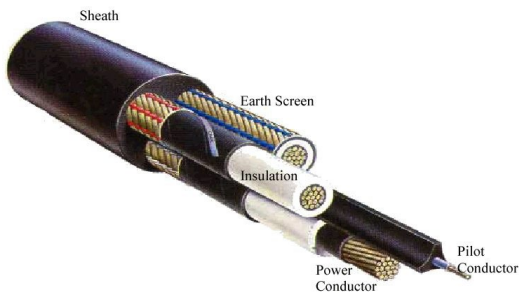

Figure 1: Cable Sheath - Internal Structure

Earth Conductors and or Screens

The earth component of the cables used can be either a metallic screen or semi-conductor. This is the most important part of the cable in terms of safety. In the event that the cable insulation is compromised, the earth conductor should provide a barrier that prevents the electrical energy from escaping the cable.

Once this electrical energy reaches the earth screen or conductor, the earth leakage relay at the substation will call for the circuit breaker to open, thus disconnecting power. External damage to the cable such as crushing, bending or stretching may cause damage to the screen, which will not be evident on visual inspection.

Insulation

Insulation is the part of the cable that insulates the electrical energy. It is commonly made from a heat-resistant rubber, and in most cables, it will be approximately 5mm thick.

Power Conductor

Made from annealed copper, the power conductor is the part of the cable that carries the energy to the machine. It is twisted down the length of the cable to improve flexibility. The cross-sectional area of the power conductor determines how much energy the cable can carry.

Pilot Conductor

A pilot conductor is a small conductor that operates as a safety mechanism. If the pilot conductor is broken (i.e. the cable is severed or torn in half) the power should be tripped by a protection relay at the substation.

6. SAFETY FEATURES

Trailing cables include protection features such as:

a) Short circuit protection.
b) Overcurrent protection.
c) Earth leakage detection.
d) Earth continuity protection.

Identifying Cables

An 'Identity Tag' showing all the particulars about a cable to which it is attached is fitted at the plug connector. Typically, the tag will indicate cable type, length, application, assembly information, and a code which will allow the full repair history of the cable to be accessed from records.

Figure 2: 11Kv HV Plug

Figure 3: Identification

7. SAFETY

Personnel must be familiar with this standard and be alert to potential hazards. All tasks must be assessed for safety.

Trailing Cable Hazards

a) All cables are to be considered live until proven dead.
b) Manual handling must be done using approved tools/devices.

Manual Handling

Manual handling of cables is a potential hazard and must be conducted only with the approved tools and devices.

Figure 4 Cable Handler – hand tool (used to make small adjustments where excessive force is not required).

8. DAMAGED CABLES

Report the incident

The Supervisor of the immediate work area and an Authorised Electrical Worker must be contacted immediately when a cable has been damaged or there is any doubt about the integrity of the cable. Keep clear of the cable until an Authorised Electrical Worker has inspected the cable. On discovery of cable damage, the area must be delineated upon discovering the cable damage to prevent access to the area.

Investigation

If a cable has visible damage, exposed conductors, signs of arcing, witness marks of energy release or witnessed flash from the cable), an incident investigation must be carried out and all information from the cable ID tag is to be record and the cable is to remain in place until the Electrical Engineering Manager (EEM) is notified.

What to do With a Damaged Cable

Damaged cables must be fitted with an Out of Service tag, on both ends, and placed at the designated cable lay down area.

9. VEHICLE INTERACTIONS WITH TRAILING CABLES

The practice of driving over unprotected cables is regarded as a serious safety breach.

If you see anyone driving over unprotected cable, you should advise your Supervisor to ensure the cable can be inspected, the appropriate investigation can take place and any necessary corrective actions taken. Cable delineation should be laid out every 20 metres when the trailing cable is on the ground.

10. TRAILING CABLE MAINTENANCE

Testing of Trailing Cables

In all cases, before a cable is re-installed and re-powered, the following inspections shall be undertaken by an Authorised Electrical Worker:

a) Inspect / examine the condition of the outer sheath of the trailing cable with particular attention to deep cuts and gouges
a) Inspect / examine the cable plug with particular attention to cracks and damage to the case. Check the witness marks at the plug for signs of movement.
b) Remove plug covers and inspect the internal connections, ensuring that:

- The insert is not cracked.
- There is no moisture or dirt present.
- Check thimbles for signs of heating, damage and tightness.
- Check plug pin retaining clips.
- Continuity testing of each core and pilot conductor will be conducted for cables under test on the cable lay down area.
- Check insulation resistance of each phase to earth and phase to phase using a 10kV insulation tester or the HPB (Transportable substation internal test device) unit.
- Ensure the “O-Ring” is in place and in good order.
- Ensure the cable ID information is fitted to the cable.

Cable Storage

Cables must be stored at designated cable lay down areas in accordance with the following requirements:

a) All trailing cables not in use and not intended for impending use should be stored in an appropriately designated cable storage area.
b) The area must be kept in a clean state, that is graded and is not prone to water ingress.
c) Cables are to be laid out in a straight line or figure 8
d) Both plugs of a stores cable must be elevated from the ground;
e) Caps must be fitted to plugs immediately on disconnection.
f) Signs identifying the cable storage area i.e. Good or Failed must be installed and must be clearly legible.
g) All weather access to the cable storage area must be provided.
h) Cables must be stored in a manner in which they can be easily accessed and reclaimed.
i) Sufficient space should be allowed to layout damaged cable prior to repair.
j) Damaged cables must have a correctly completed “Out of Service” tag attached.

Photograph 8: Plug kept off the ground

11. COMMON DAMAGE TO TRAILING CABLES

Bending

Bending a cable too tightly causes internal damage, which can reduce the life of the cable, or in some cases cause immediate cable failure, resulting in the risk of injury to personnel, and/or machinery downtime. The use of "radius devices" such as half-moons ensures cables are not bent too tightly when under strain, for example when being towed or suspended. The radius of these devices can be used as a gauge to ensure cables are not bent to tightly when being laid-out.

Warning

Tight bending of cables will lead to failure.

Stretching

Stretching and over-tension will damage the pilot conductor, power conductors and earth screens.

The most common causes of stretching damage are:

a) Towing excessive lengths of cable;

b) Dropping excessive lengths of cable over a high wall without appropriate support (live plugs are not to be dragged over highwalls);

c) Cable towers being spread too far apart.

Photograph 5: Witness mark (silver)

Warning

Over tension will lead to reduced insulation of power conductors and failure.

Crushing

Crush damage often cannot be seen from the outside of the cable. The sheath appears to be normal, yet inside the main electrical components may have suffered significant damage.

Trailing cables are most commonly crushed by:

a) Vehicles/equipment driving over them;

b) Laying out cable near the base of a highwall where rocks can potentially fall;

Warning

Crushing may not be evident immediately and will lead to failure.

Cutting

Cuts are visible damage. They are the most common types of damage that occurs. Like crushing, the degree of damage depends largely on the force of the impact.

Trailing cables are most commonly cut by:

a) Coming into contact with dozer/grader blades.

b) Being dragged over rocks;

c) Removing slings with sharp implements.

d) Sharp protruding obstacles sticking out of a cable tractor's implement.

Sheath Wear

Sheath material degrades over time from general use (i.e. UV rays from sun exposure, weathering). It is therefore important to recognise that older cables have softer sheaths that are more prone to damage when dragged. Sheath damage is introduced when cables are moved excessive distances over rough ground, or when sheaths come in contact with sharp rocks or edges.

Warning

Sheath wear reduces the thickness of the protective outer layer.

Figure 7: Example of rocks gathering on cables

Internal Failure due to Contamination

The main type of contamination damage to trailing cables is from water. Water damage often leads to immediate failures, but it also contributes to the long-term degeneration of the earth screen. Many coupler failures are the result of contamination. Contamination failures are most commonly due to:

a) Laying out cable through water or flooding prone areas;
b) Poor storage (i.e. leaving caps off plugs when storing).
c) If cable plugs or cable are found submerged in water the cable must be isolated to remove the risk of cable failures in an energised state.
d) Operations team to de-water the area or remove cable from body of water while following the correct cable handling practices
e) Testing of effected cables must be completed to ensure no water ingress has occurred during the relocation of dewatering of the area.
f) If cable alone is found submerged isolations must take place before cable is handled or dewatering commences.

Warning

Plugs and cables must never remain submerged.

Figure 8: Example of a cable sitting in water

Common Damage to Cable Plugs

When a cable has been pulled back or bent sharply close to the coupler, conductors on the outside pull backwards out of the plug and dislodge. Poor contact of the conductors in the plug can lead to hot spots inside the plug. As a result in extreme cases, severe arcing may occur in the plug due to an open circuit.

Witness bands on the cable near the plug casing provide an indication of the cable pulling away from the plug. The cable must not be introduced to a circuit, it must be placed out of service and reported to your Supervisor. If the cable is in an energised circuit, the cable must be inspected by a competent Electrical Worker, and organised to be replaced at the first opportunity.

Cable plugs that show signs of cracks or impact damage must not be included to a circuit, and if identified within an energised circuit, cable must be inspected by a competent Electrical Worker and organised to be replaced immediately (word better) actioned.

12. WORKING WITH CABLES GUIDELINES

General

Relocating and working with trailing cable is an essential task for the operation of electrically powered machines.

It is important to note that:

a) All work must be in strict accordance with relevant site standards, standard operating procedures and work instructions.
b) Only approved devices are to be used when relocating trailing cables.

Cable Plugs

Cable plug stands must be used to elevate and protect plugs from water and mud. No Cable plugs shall be moved while energised.

When working around cable plugs, the authorised worker must use multiple man lifts and/or mechanical aid when joining and lifting plugs.

Cable Plugs used as Isolation Points

Cable plus can be used as a point of isolation provided:

a) A cap is fitted.
b) A suitable, lockable lanyard is passed through the unused bolt holes and captures the cap and plug.
c) A hasp is placed first to the locking device.
d) The cable is not to be moved and relocated while locked.

13. Working with Cables

Towing Cables using Slings

The use of slings is common place when towing/re-locating cable within an existing cable run.

To prevent bending the cable too tightly two slings of suitable length with diameter are spaced at least one metre apart. Also keep in mind the following requirements when towing/pulling: -

a) Under no circumstances is one sling to be used to tow cables unless it is the first straight tie off point from a skid or boat.
b) Do not attach towing equipment closer than one (1) metre to cable repair

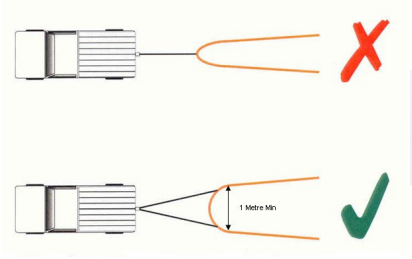

Figure 9: Set up for Light Vehicle Cable Towing Using Two Slings

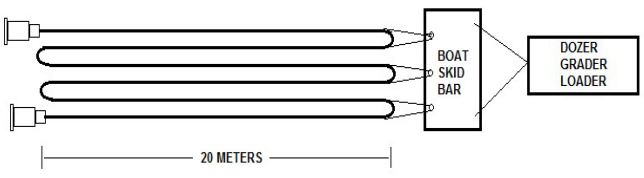

Figure 10: Maximum loop length and basic design for minor relocations. 30m loops, with the exception of dragline tail cables that may be longer loops as required for fitting to full pipe covers and general handling in that area.

Connecting Towing Slings

Cables loops should be attached to a cable with two slings, one (1) meter apart, that are looped around the cable twice and looped back through the sling to avoid slippage. When connecting slings to cables, the CMW must ensure that:

a) All slings are removed from the cable immediately after use.

b) Kinks are never pulled out of a cable – (by using an approved cable handler, turn the cable before the kink develops).

c) Care is taken to avoid knots developing in the cable.

d) Cables do not go underneath other equipment.

e) Cables are never pulled or towed or dragged over sharp objects or around large rocks.

Figure 11: Remove folds/creases to minimise strains on cable

Examples of Other Towing/Pulling Equipment

When cables need to be repositioned, a cable pulling device is used to prevent damage from sharp bends. Half-moon shaped brackets, correctly fitted to the cable, mounted on towing vehicles or towed with slings can be used to pull or tow cables.

Figure 12: Cable Relocation Roller

Figure 13: Cable Handling Puller

Figure 14: Light vehicle with cable puller

Figure 15: A half moon cable handling bracket

When a cable is directly attached, via a sling and pulling device, to a vehicle, that vehicle must be a light/medium vehicle or cable tractor.

Uncontrolled Buried Cable

A Take 5 is to be conducted prior to commencing the task and ensure that the buried cable is isolated prior to commencing retrieval.

Once the cable has been uncovered it must be fully inspected and tested by an Authorised Electrical Worker. For all recovery operations, a spotter (as assessment against this standard) us to be utilised and maintain direction communications.

Cable Demarcation

All cable runs must be suitably marked with blue witches' hats, with reflective sleeve moulded, at regular intervals to increase the visibility of the cable route (access roads, high interaction areas, etc.). These are to be installed when cable is being routed.

When a cable is picked up, the disused witches' hats and cable stands are to be picked up and stored at the cable lay down area.

They are to be placed at a recommended 20m interval along cable route.

When marking cables along high interaction areas, such as on the edge of pre-strip/ coal mining haul roads, the cable is to be marked a minimum of every 20 metres.

The minimum standard for spacing required between markers for 'looped sections' must be:

a) Adequate amount of markers placed to clearly identify the outer perimeter of the looped area.

b) For multiple loop set up's a marker must be placed (as a minimum) at the outer perimeters and equally spaced between.

The requirements of this standard will only be met when the markers placed are in good condition, standing upright and clearly visible. These cable hats must not be placed for any other use on site.

14. CABLE ROADS/ROUTES AND MACHINE CROSSINGS

Cable Route Planning

A procedure for cable route planning is attached in Appendix A – Procedure for Cable Route Planning.

There are also some common guidelines for planning a cable route, they are to:

a) Choose a cable route clear of low spots that may hold water after rain.

b) Avoid sharp rocks and bottlenecks that prevent access to both sides of the cable.

c) Consideration must be made in the plan to position plugs on level ground to allow the use of mechanical aids.

d) Take into account other operations in the area, e.g. blasting.

e) Ensure cables do not impede vehicle access to substations or machines.

f) Graders should keep a safe working distance of 2 metres from trailing cables on machine benches and 1 metre on ramps and light vehicle roads

Figure 18: Poor standard of cable route, not wide enough.

Figure 19: Good standard for cable route.

Cables Placed on Bunds

Cables can be placed on the top of bunds to protect them in high traffic situations by applying the following:

a) Cable to be positioned using an excavator and appropriate cable handling device;

b) Plugs must be on stands

c) Work, coupling and uncoupling, on the cable must be completed or undertaken on the ground and the Operations circuit closed while CMW's are conducting works.

Permanent and Temporary Pipe or Culvert Crossing Arrangement

Permanent and temporary cable crossings can be installed using pipe or concrete culverts. Note the following:

a) Cables must not be directly buried in the ground. A culvert must be used if the cable is to be below the earth. The culvert must be constructed to protect the cable from physical damage and allow an air gap between it and the fill material;

b) Any pipe or culvert must be buried to a minimum of 1.2 metres.

c) Edges of the road where the pipe or culverts are buried are to be clearly marked.

d) The pipe or culverts used must be at least four (4) times wider than the cable diameter; this allows the plug to be pulled through and doesn't de-rate the cable load capability;

e) The Pipe or culvert must extend out each side of the road crossing by 1 metre.

f) Suitable fine material is to be placed over piping or culverts to a minimum coverage of 500mm to prevent damage by rocks.

g) Buried cable signs must be placed at each side of the crossing warning machine operators.

The ends of the pipe/culverts must not be covered and must drain naturally.

Figure 24 Permanent Cable Crossing – Pipe

15. TRAILING CABLES OVER HIGHWALLS CABLE TOWERS

General Instructions for use, as displayed on each tower, must be followed by trained, authorised and competent Coal Mine Worker.

***Note** - Operators must never assume that cables are in a certain location or position. Visual sighting of the cable is the only effective way. An extra five minutes to check may save personal injury, damage and downtime.*

16. ROLES AND RESPONSIBILITIES

SSE	Shall review and approve this procedure.
HST Manager	Shall ensure that all provisions of this procedure are implemented, and that compliance is achieved.
Superintendents	Shall be responsible for their area of operations and the implementation and application of this procedure; Provide adequate training, information, structure and supervision to ensure that this procedure is implemented; Carry-out a periodic review of activities to ensure the appropriate application and understanding of this procedure; and Ensure immediate and appropriate steps are taken to investigate and rectify any risks to health and safety arising from these activities.
Supervisors	Ensure all CMWs are familiar with, have access to and comply with the requirements set out in this procedure.
All CMWs (including visitors and contactor)	Shall comply with the requirements of this procedure.

17. REFERENCES

Queensland Coal Mining Safety And Health Act 1999

Queensland Coal Mining Safety And Health Regulation 2001

Queensland Electricity Act 1994

Queensland Electricity Regulation 2006

Queensland Electrical Safety Act 2002

Queensland Electrical Safety Regulation 2002

18. REVIEW

This document shall be reviewed at a minimum every two years, or as follows:

- when there is a change of method and/or technology and/or legal or other requirement that may affect the accuracy of this document.
- when operational changes occur that effect the currency of the document.
- when there has been a significant event to which this document was relevant; and
- as a result of relevant audit findings.

19. DOCUMENT CONTROL

General Instructions for use, as displayed on each tower, must be followed by trained, authorised and competent Coal Mine Worker.

Version	Date	Description	Document Controller
01	06/03/2025	Review & Formatting	Kelly Jensen