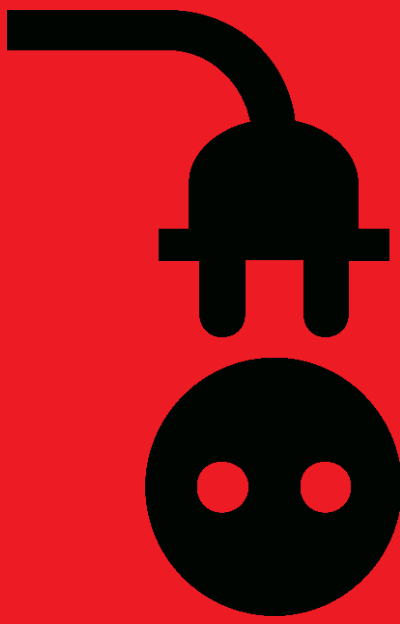
ELECTRICAL SAFETY



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6 ELECTRICAL SAFETY

Intent

The intent of this Protocol is to eliminate or minimise the potential for fatalities, injuries and incidents arising from risk associated with contacting energised electrical conductors or exposure to faulty electrical systems; these can result in secondary hazards such as arc blast, fire or ignition of explosive atmosphere.

This document should be read in conjunction with the Glencore Electrical Installation and Equipment Guideline [1].

Assets may impose higher standards than those set out in this Protocol to address requirements such as local legislation.

Related Life-Saving Behaviours

1. Always come to work drug and alcohol free.
2. Always use or wear critical safety equipment.
4. Only operate equipment if trained and authorised.
5. Always isolate and 'test for dead' prior to working on energy sources.
6. Never modify or over-ride critical safety equipment without approval.
8. Never enter danger zones without approval.
9. Always report injuries and HPRIs.

Key actions

1. A risk assessment must be conducted to identify, analyse and evaluate all electrical source related risks.
2. Develop and implement an Electrical Engineering Control Plan (EECP) to manage and control the identified risks.
3. Implement electrical standards highlighted in the EECP for the identified risks using the Glencore Electrical Installation and Equipment Guideline as a source of specific requirements.
4. Only trained, competent and authorised or appointed personnel may conduct electrical work.
5. Provide training on the relevant and applicable standards and assess the trainees' competency and understanding.
6. Assign accountability for implementing and maintaining these processes.
7. Monitor that controls continue to deliver the required outcomes.

6.1 General Requirements

6.1.1 A documented risk assessment must be conducted to identify the hazards, assess the risks and implement controls related to the risks associated with electrical sources.

6.1.2 An Electrical Engineering Control Plan must be developed, implemented and maintained to:

a) Address the identified risks in 6.1.1 above,

b) Provides an overall framework to control and govern the provisions of this Protocol.

c) Include the Life cycle management process for plant and equipment

6.1.3 Isolation procedures and associated permits must be developed, implemented and maintained for the management of electrical installations including their energy sources.

6.1.4 An assessment of overhead power lines must be conducted, and a system implemented to control the risks associated with working in close proximity including prevention of contact by personnel or equipment.

6.2 Systems and Processes

6.2.1 Unless specifically approved, there should be no "Live Testing" undertaken in any electrical installations that are energised above extra low voltage. A live testing process and system of approval for this type of testing needs to be developed and implemented. This must include as a minimum:

a) That live testing will only be a last resort when there are no other practical means to complete the task;

b) Competency and training for the personnel involved;

c) Management of the energy involved during testing i.e. control versus power circuits and the additional precautions that need to be applied;

d) Use of required test equipment;

e) A suitable and approved method of verifying the correct operation of test instruments using a known source (e.g. battery-operated test units; placing the probes on exposed live busbars that are not IP2X rated is not considered an acceptable means of testing an instrument);

f) Completion of a documented risk assessment (e.g. JSA) or procedure for all live testing tasks;

g) A process for approval to undertake live testing (live testing permit or similar);

h) The assignment requirement for a safety observer where the risk assessment identifies the need;

i) PPE requirements; and

j) Supervision requirements.

6.2.2 There must be a process implemented for the management and safe use of portable electrical tools. The process must consider the asset's specific environmental conditions, as well as inspection and testing requirements. Use of battery or pneumatically operated tools are preferred, where practicable

6.2.3 Assets must develop a process for the restoration of power and specifically detail the necessary

steps which must be taken before resetting any tripped circuit breakers e.g. earth leakage, short circuit and overload, or replacing blown fuses on all electrical systems above extra low voltage. This process should also include a register for recording any trips, particularly on high voltage installations.

6.2.4 A study must be completed to calculate the specific arc flash hazard at switchgear and electrical panels and identify where the use of appropriately rated personal protective equipment for electrical work may be needed.

6.2.5 The appropriate personal protective equipment category rating (refer NFPA 70E [2]) must be identified for all electrical installations and signposted accordingly. The use of engineering controls to mitigate the hazard must be considered (e.g. arc fault detection relays, HRC fuses, remote switching).

6.2.6 Assets must develop a system to manage any high voltage overhead power lines and cables including clearances from plant and equipment, as well as maintenance and inspection requirements. This must include condition monitoring / inspection of the joints and terminations by either a visual inspection or using approved test equipment such as thermographic cameras.

6.2.7 The steps for the management of electric shock must be developed, implemented and maintained; and include as a minimum:

a) That all electric shocks must be reported;

b) Isolation of the power supply;

c) First aid treatment of personnel;

d) Preservation of the scene;

e) Barricading the area;

f) Notification to relevant supervisors/managers; and

g) Investigation of the cause and corrective actions.

6.2.8 A labelling standard must be implemented and maintained to fit appropriate identification and warning labels on all electrical installations.

6.2.9 There must be a system implemented and maintained for the specification and layout of all electrical distribution networks, including single line diagrams, asset services drawings for any high voltage overhead power lines or high voltage underground / buried cables, system fault level calculations, equipment details, electrical protection settings and discrimination curves.

6.2.10 There must be a system implemented and maintained to control the risks associated with excavation where electrical cables may be present.

6.2.11 A maintenance management system applicable to all electrical equipment must be developed, implemented and updated. It must include maintenance and inspection requirements as well as inspection timing.

6.2.12 A commissioning process must be developed and implemented to inspect and test all electrical installations energised above extra low voltage after any construction, alterations or repairs have been undertaken and prior to placing the plant or equipment back into service. Inspection and test results must be recorded and verified by relevant supervisors prior to completion of

the task.

6.2.13 There must be a process for removing electrical equipment from service if not fit for use or purpose; e.g. a defect management system and the placing of an Out of Service tag on the defective equipment's applicable isolation point(s).

6.3 Installations and Equipment

6.3.1 Electrical installations, including wiring and earthing must be specified, and maintained in compliance with relevant legislation, standards, codes of practice and any other external requirements applicable to the country / location of the asset.

6.3.2 Assets must have a documented electrical installation standard detailing the specific electrical requirements for installations. Guidance for developing these standards may be obtained from the Glencore Electrical Installation and Equipment Guideline [1]. This standard must include, as a minimum:

a) Provision of protection against dangers arising from contact with parts of the electrical installation that are live in normal operation. This must be achieved using one or more of the following methods:

1. Insulation;
2. Barriers or enclosures;
3. Obstacles;
4. Placing out of reach.

b) All electrical installations and equipment must be at least IP2X [3] rated in relation to any accessible exposed electrical conductors energised above extra low voltage;

c) All circuit breakers / isolators must be fitted with phase barriers and shrouds on both the line and load sides of the circuit breaker / isolator as specified by the manufacturer. Any busbar installations to and from these circuit breakers must be appropriately designed with short circuit and arc fault mitigation included e.g. insulation, segregation distances, and phase barriers etc.;

d) Minimum approach distances to live electrical conductors must be documented and signposted, this must be based on the IEC/NEMA/SAI or country standards applicable to the location of the asset. Where no standards are applicable, and conductors are not IP2X rated, then:

1. A minimum approach distance of 500mm must be maintained for installations up to and including 1000V AC or 1500V DC;
2. A clearing distance of at least 2.0 metres must be maintained with all HV installations energised with Voltage of up to and including 132kV (applicable only to accredited personnel with an observer);

e) All spare wiring and electrical cables must be treated as live, adequately insulated, and tagged to notify others of the status; i.e. spare, redundant, damaged; multiple spare cores may be fitted with a heat shrink boot arrangement in lieu of individual cores;

f) An earthing system must be provided to ensure that all mains-fed electrical equipment, and

all conductive parts of that equipment, other than active conductors, are connected in order to:

1. Enable automatic disconnection of supply in the event of a short circuit to earth fault or excess earth leakage current in any part of the installation;
2. Provide an effective and reliable low impedance fault path capable of carrying earth fault and earth leakage currents without danger or failure from thermal, electromechanical, mechanical, environmental and other external influences or another approved system that achieves an equivalent level of safety; and
3. Mitigate any differences in potential across any exposed conductive parts by having adequately sized earth bonds in place.

g) Switch rooms and substations must have as a minimum:

1. A single line drawing showing all high voltage cables and switchgear on display;
2. A single line high voltage drawing showing all points of isolation available on the electrical distribution system for that installation / location on display;
3. A single line drawing showing all points of isolation available for the Low Voltage electrical distribution system for that installation / location on display;
4. Electrical drawings available for the specific electrical installation.

h) All electrical equipment including enclosures, motor control centres, distribution boards, junction boxes etc. must be installed in a position where they can be easily accessed and provide a safe work area for personnel. A minimum distance of 600mm from the arc of the door must be kept clear in front of these enclosures;

i) All electrical installations must be fitted with permanent type labels indicating:

1. Plant or identification number;
2. Plant description and what it supplies;
3. Where plant is supplied from or isolated at;
4. Danger sign indicating the maximum voltage found in the enclosure;
5. Danger sign indicating that only authorised personnel are permitted access;
6. Danger sign indicating to isolate elsewhere prior to opening door or removing cover where exposed live conductors are not IP2X rated behind them; and
7. Electric shock / resuscitation in switch rooms and substations.

j) All electrical switch rooms and substations must be locked and inaccessible to unauthorised personnel. To enable removal of power in the event of an emergency, an external emergency stop device(s) must be incorporated unless this creates a greater risk than it mitigates. A risk assessment must be undertaken to support the decision if an external emergency stop is not provided at an installation.

k) Provision for managing Extra Low Voltage installations must be implemented and maintained and include mechanical protection, support and segregation of all wiring from mechanical services e.g. brake lines, fuel lines, hydraulic lines. Battery cables must be individually mechanically protected and supported along their entire length.

The installation of electrical protection devices and appropriate isolation devices e.g. battery isolator/s, must form part of this documented standard.

6.3.3 A fault level and protection study must be completed and documented to determine the asset's electrical protection requirements and, as a minimum, must ensure that all faults must be cleared in the minimum possible time and all fault clearing times must be within the fault withstand capability of the equipment.

6.3.4 Electrical protection devices, including overload, earth leakage and short circuit protection, suitable for the application, must be installed on all final distribution circuits energised at low voltage.

a) Earth leakage protection devices must be installed on all distribution circuits, including LV trailing cables, and they must be set to trip at a maximum of 500mA.

b) All final sub circuits rated up to and including 32A, including general purpose outlets and lighting circuits, must have earth leakage protection provided, which is set to trip at a maximum of 30mA.

c) These devices must be suitable for the application and settings documented in the asset's electrical protection standard. Where it is not practical, for safety reasons or where opening a circuit could cause a greater danger than the trip itself, i.e. lifting magnets, exciter circuits etc. these must be supported by a documented risk assessment and any other safety measures implemented as an outcome.

d) Testing of electrical protection devices must be conducted at pre-determined intervals recommended by either the manufacturer, relevant country standards, or risk based depending on the asset's requirements. Test results must be recorded and retained for a period specified in the document control system.

6.3.5 Certified explosion protected electrical enclosures and equipment must be installed where located within potentially explosive atmospheres and / or as described by standards applicable to the location of the asset.

6.3.6 All extension leads outside an office environment must be of robust construction suitable for the installed conditions in an industrial environment. The preferred leads are the screened type, which are fitted with IP56 plugs and sockets. The screen in the extension leads must be connected to the earth terminal at both the plug and socket ends of the lead.

6.3.7 There must be a process for managing welding machines and associated accessories that includes as a minimum:

a) Installation of a Voltage Reduction Device (VRD) on all Manual Metal Arc Welding machines;

b) Cables must only be joined using the approved plug type arrangement;

c) The ground / earth return clamp must be taken as close as practicable to the work area and effectively attached;

d) Welding machines must be maintained to a standard as described by the manufacturer and any standards applicable to the location of the asset, i.e. IEC / NEMA / SAI standards etc.;

e) Welding leads must be inspected prior to use by the person using the equipment; and

f) Welding leads must be inspected formally on a risk-based time period and tagged to indicate they have been inspected by a competent person, e.g. monthly.

6.3.8 All high voltage power cables (excluding aerials) must be insulated, terminated and only joined / spliced using approved methods available from recognised manufacturers and by competent and authorised personnel; this must provide the correct insulation properties, IP rating, and phase segregation as approved for the type of cable being joined. The cables must be tested to the required standards and a test sheet produced for the completed joint or splice prior to energisation.

6.3.9 Any cables above extra low voltage, excluding trailing and reeling cables must be installed and arranged to minimise damage due to impact or interaction with mobile equipment. Inspections must be conducted on a regular basis.

6.3.10 Any cables that are energised above extra low voltage must be designed for the environment in which they will be used and installed. Trailing cables on machines and cables submerged in water are examples of this requirement.

6.4 Competency and Training

6.4.1 Assets must identify competency requirements and associated training for relevant personnel in relation to electrical safety. This must include refresher training as well as ongoing maintenance of electrical competencies. Competency requirements include:

a) Appointment of Person/s with appropriate electrical qualifications ~~are~~ to develop and review the standards and procedures for the installation, commissioning, maintenance and repair of electrical plant and installations;

b) Appointment of Person/s to supervise the installation, commissioning, maintenance and repair of electrical plant and installations;

c) Persons appointed to do electrical work must meet local legislation competency prerequisites;

d) The identified training must meet competency requirements, legislation, codes of practice, design criteria and asset or regional protocols, as well as relevant procedures and permit systems; and

e) Only trained, competent and authorised or appointed personnel are to conduct electrical work.

6.5 Additional requirements for Catastrophic Risk (PMC 5) Situations

Nil

6.6 Definitions

Appointed or Authorised Person

A person authorised in writing by the Manager or their delegated representative to carry out specific duties, such persons being trained and deemed competent for the purpose of the clauses in which the term is used. An example is Authorised Isolators and Permit Holders.

Competent Person

A person having the appropriate experience, knowledge, skills and capability.

Dead

Not electrically “Live” or “Energised”.

Electrical Testing (also see Live Testing)

The application of test instruments to terminals whilst they are energised above extra low voltage.

Electrical Work

Work that includes:

- connecting electricity supply wiring to electrical equipment or disconnecting electricity supply wiring from electrical equipment, or
- installing, removing, adding, testing, replacing, repairing, altering or maintaining electrical equipment or an electrical installation.

Energised

Connected to a source of electrical supply or subject to hazardous induced or capacitive voltages.

Ingress Protection (IP) classification

A degree of ingress protection in accordance with international standards.

IP2X *[3]*

A 12.5mm diameter object or finger size should not be able to gain access to exposed live conductors without one of the following conditions being met:

a) The use of a key or tool is required to access the enclosure; or

b) The door is interlocked with the power supply to prevent the door from being opened whilst the power supply is ON; or

c) There is a secondary barrier or cover fitted internally to cover any exposed conductors and prevent a person from inadvertently coming into contact.

Isolated

Disconnected from all possible sources of electricity or other energy supply and rendered incapable of being made energised without premeditated and deliberate action.

Isolation Point

A point that has been identified as the lockable isolator for an identified energy source for a specific piece of plant or equipment.

Live Testing

A last resort process where it cannot be done any other way, using both approved test instruments and test methods to measure voltage or current values, as an example, without isolating the supply and maintaining a distance outside the “near” zone.

It would not be considered to be “Live Testing” when:

- The power supply is isolated to allow test probes to be attached at the test point, the person conducting the test stands clear i.e. outside the “near zone” where conductors are not IP2X rated, and the power is restored to allow the values to be observed; or
- Tong type instruments (ammeters) or induced voltage detectors, are being used, where the terminations are rated IP2X or outside the near zone, from any exposed live conductors; or
- Testing for zero energy i.e. using an approved testing method to verify an isolation has been effective.

There is to be NO live high voltage testing undertaken at all i.e. using handheld probes to test for a voltage source. (This excludes permitted “phasing” where Safe Work Procedures have been developed using approved test equipment)

Near (in context of Live Testing)

Proximity to exposed energized conductors where there is a possibility of either of the following coming within 500mm of the energized exposed conductors above Extra Low Voltage.

- A person’s body.
- Any object which a person may be carrying or touching during the course of the work, that is not designed for use on energized conductors operating at that voltage.

Permit System

Formal system required for specific tasks or activities i.e. working in confined space, working at heights, hot work etc., whereby a permit has to be issued prior to commencing work.

Training

The initial training to verify competence and subsequent refresher training to verify that competencies have been retained.

Voltage

Potential difference between conductors and between conductors and earth.

Categories	
Extra Low Voltage (ELV)	Not exceeding 50V AC or 120V ripple-free DC
Low Voltage (LV)	Exceeding extra low voltage, but not exceeding 1000V AC or 1500V DC
High Voltage (HV)	Exceeding low voltage

It is recognised that voltages vary from country to country and this table is a guide only with the risks required to be appropriately managed for these variations in voltage levels.

Tools (See Glencore HSEC Intranet)

- Electrical Installation and Equipment Guideline
- FHP 06 Electrical Safety Self-Assessment Spreadsheet;
- FHP 06 Electrical Safety Audit Workbook;
- FHP 06 Electrical Safety Tool Box Talk
- Electrical Engineering Control Plan (EECP) Template

***Note**: Application of this Protocol must also comply with the General Mandatory Requirements outlined in Section II of the Glencore Life-Saving Behaviours and Fatal Hazard Protocols publication.*

6.7 References

[1] Glencore (2019); Glencore Electrical Installation and Equipment Guideline (G-S-GDL-0006).

[2] NFPA 70E, Standard for Electrical Safety in the Workplace.

[3] IEC 60529:1989/AMD2:2013/COR1:2019.

6.8 Accountabilities

Team	Accountabilities
Glencore Corporate	• Maintain and update this protocol.
Department	• Oversee the implementation of this protocol within department and apply assurance processes.
Asset management	• Apply the requirements of this protocol.
All employees/contractors	• Comply with relevant requirements of the protocol.

6.9 Control and Revision History

6.9.1 Document Information

Property	Value
Approved by:	Lucy Roberts
Document owner:	David Mellows
Effective date:	15/10/2020

6.9.2 Revision

Version	Date Reviewed	Review Team	Nature of Amendment(s)
1-0	29/10/2013	HSEC Corporate Leads	First publication
2-0	06/11/2019	David Mellows / Mark Davis (Em Dee); Department technical experts	Elimination of the three implementation stages. Additional clauses added to control the causes for HPRI and fatality experience, coming mostly from existing guideline and covered in legislation in many but not all countries. Clarification where required after site feedback. Legal review completed.
3-0	26/07/2020	David Mellows / Mark Davis	Updated clause 6.3.2 (f) 1 in relation to earth fault protection – removed “Protected part” in relation to an electrical installation to prevent any confusion with terminology. The Glencore “Electrical Installation and Equipment Guideline” has been updated

			with further clarification to these installation requirements with drawing examples and relevant details. Included the requirements for an Electrical Engineering Control Plan to be developed, implemented and maintained. Update to Key Tasks