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SAFETY AND HEALTH STANDARD			
KUC ELECTRICAL STANDARD			
Effective Date: 11/9/2016	Standard: 15.1	Document Number: KUCSH0065	Rev: 0

15.1 **INTRODUCTION**

15.1.1 This standard is based off the Rio Tinto C2 Electrical Safety Standard. This standard applies to all electrical work above 50 volts AC and DC, and is intended to provide guidelines regarding:

- safe electrical work procedures,
- electrical competency requirements,
- access to electrical "controlled areas",
- grounding, and verification of grounding integrity
- portable electric equipment
- Arc Flash Programs
- Minimum PPE requirements and care and maintenance of the PPE
- Electrical transmission lines.

This standard is applicable to all electrical installations exposed to the rigors of an industrial environment. Not all of these clauses will be applicable to electrical installations in a commercial environment. For all electrical equipment, regardless of the location, all relevant codes and regulations need to be adhered to.

All electric shocks, no matter how minor, must be reported as an incident, and will be investigated by the site electrical lead.

This standard defines the minimum requirements. It is at the discretion of individual sites to establish rules and procedures that exceed these requirements. If these requirements cannot be met, deviations can be approved by the C2 committee, and the site General Manager, and will be accompanied by a written risk assessment and approved SWI.

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15.1.2 DEFINITIONS

- 15.1.2.1 **COMPETENT PERSON**- a person having demonstrated the knowledge and abilities that fully qualify them to perform the duty to which they are assigned and who because of training and experience is capable of identifying hazardous or dangerous conditions and of instructing other employees to identify such conditions.
- 15.1.2.2 **AUTHORIZED PERSON**- a person approved or assigned by plant management to perform a specific duty or to be at a specific location.
- 15.1.2.3 **QUALIFIED PERSON**– A person who, by possession of a recognized degree, professional certificate, or who, by extensive knowledge, training, and experience in the applicable field, has successfully demonstrated the ability to solve or resolve problems and is capable of design, analysis, evaluation and specifications relating to the subject matter, the work, or the project.
- 15.1.2.4 **TRAINED PERSON**– A person who has successfully completed an approved course related to the subject. Records of the training must be maintained to verify “trained person” status.
- 15.1.2.5 **ELECTRICAL GROUNDING**- connected to or in contact with earth, or connected to some extended conductive body that serves in place of earth, to provide a path for leakage and / or fault currents to prevent an objectionable potential above ground on non-current carrying metal parts.
- 15.1.2.6 **GROUNDING SYSTEMS**- typically include the following:
- Equipment Grounding Conductors- the conductors used to connect the metal frames or enclosures of electrical equipment to the grounding electrode conductor.
 - Grounding Electrode Conductors- the conductors connecting the grounding electrode to the equipment grounding conductor.

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- Grounding Electrodes- usually driven rods connected to each other by suitable means, buried metal, or other effective methods located at the source, to provide a low resistance earth connection.

15.1.2.7 **ELECTRICAL WORK** – Any interactions with equipment that has the potential to be energized at voltages above 50 Volts AC or DC. This includes (but not limited to):

- testing,
- fault finding,
- switching,
- racking in and out of breakers
- opening panels
- verification of voltage
- Live commissioning
- Applying safety ground
- Any other interaction, intended or not, that can change the state or position of the electrical equipment.

It does NOT include:

- visual inspection with panels closed
- equipment audits
- site visits
- walk downs
- reading of installed meters
- interrogation of relays
- uploading or updating of relay parameter

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- Infrared Thermography through installed, approved windows

15.1.2.8 **AUTHORIZED ENTRANT** – A person who has been trained and approved by the plant electrical superintendent to be in possession of a key that will allow access into restricted areas. This authorization is only applicable to the plant for which the person has been authorized.

15.1.2.9 **ENERGIZED ELECTRICAL WORK** – Working on or near exposed energized electrical parts.

For the purpose of this standard, near has the same meaning as “Restricted Approach Boundary” as defined in NFPA 70 E. The table below defines the Restricted Approach Boundary (RAB):

Voltage	RAB
50V to 150V	Contact
151V to 750V	12 inches
751V to 15kV	26 inches
15.1kV to 36kV	31 inches
36.1kV to 46kV	33 inches
46.1kV to 72.5kV	39 inches
72.6kV to 121kV	40 inches
138kV to 145kV	46 inches

15.1.2.10 **VOLTAGE CLASSIFICATION: (IEC 60038)**

Low Voltage:	up to 1000V
Medium Voltage:	1000V to 35kV
High Voltage:	35kV to 230kV
Extra High Voltage:	above 230kV

15.1.3 **REQUIREMENTS**

15.1.3.1 All electrical installation work shall be conducted by competent personnel in accordance with governing regulation, code, design

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criteria and safe work procedures.

- 15.1.3.2 There shall be demonstrated job and equipment-specific electrical competency standards and safe work procedures for all electrical work, i.e. construction, decommissioning and demolition of electrical equipment. The competency standards shall specify the frequency for re-certification, which shall be no less than every two years and address job and equipment-specific safe work procedures.
- 15.1.3.3 There shall be an arc flash protection program in place to determine incident energies and define the appropriate PPE and associated procedures to mitigate the hazard. The purpose of the Arc Flash Protection Program should be to reduce incident energies to as low as practically possible. The Arc Flash Study that forms part of the program should be conducted:
- At least every 5 years, or,
 - after changes that could reasonably affect the incident energies.

Arc Flash Labels (See exhibit 15.1.7) will be posted on all electrical panels greater than 480V. Panels less than 480V, but fed off a low impedance transformer of more than 125KVA will require Arc Flash Labels.

- 15.1.3.4 Electrical safety devices such as Ground Fault Circuit Interrupters and overload protection shall be installed on all single phase, 125V final distribution circuits. Where the installed receptacle is not fitted with a GFCI, the GFCI will be an integral part of the attachment plug or located in the power-supply cord within 300 mm (12 in.) of the attachment plug. Listed cord sets incorporating ground-fault circuit-interrupter for personnel shall be permitted.

The GFCI unit shall be tested before use by using an approved test device, or by activating the test function and reset buttons integral to the GFCI units.

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15.1.3.5 Fixed Electrical equipment shall be inspected and the ground continuity tested at least once a year and the findings recorded. Records in SAP are acceptable.

15.1.3.6 There must be a system for removing electrical equipment unfit or unsafe for purpose. Each plant shall maintain a register of unfit, unsafe, obsolete and decommissioned electrical equipment. There shall be an action plan to remove this equipment from site. Equipment that cannot be removed needs to be rendered safe, and must be on the register until an opportunity to remove the equipment arises.

15.1.3.7 There must be a system for maintaining an up-to-date set of single line diagrams with supporting documentation showing:

- System fault calculations;
- Equipment details;
- Electrical protection discrimination curves; and
- Cable ratings.

Pertinent revisions shall be properly engineered, approved and logged. (See Exhibit 15.1.1) Ongoing updates to distribution panel schedules, fault calculations, equipment details, protection discrimination curves and cable ratings must also be engineered, approved and logged.

15.1.3.8 All energized electrical work, with the exception of voltage verification, will require either a written safe work procedure or an Energized Work Permit.

Before authorizing any Energized Work Permit for Electrical work, the person authorizing the Energized Work Permit will ensure that the applicant is aware of the existence of adjacent live equipment, voltage level, arc flash incident energy and understanding of the

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flash protection boundary. See Rio Tinto Kennecott Health and Safety Standard 16.12.3.9

- Welding where the open circuit voltage exceeds 50 volts DC or 50 volts AC will be considered Energized work unless an approved Voltage Reduction Device (VRD) or an electrode switching device with a trigger action is used

15.1.3.9 Access to an electrical cabinet or other enclosure with exposed energized terminals in excess of 1,000 volts is prohibited.

15.1.3.10A "Close Proximity Permit" must be completed before conducting all work (not just involving mobile cranes) that is within 15 feet of an Overhead line; within any fenced substation; within any work area where exposed buses are present; or when moving loads over overhead lines or substations. See RTKC Standard 16.4, paragraph 16.4.2.14. Personnel working on Electrolytic Cells, and Trained, Competent and annually Authorized Electrical Personnel conducting standard work are excluded from this requirement. In the case of this exclusion, there must be an approved process in place to mitigate any risks associated with these hazards.

Whenever excavations are being performed, the requirements of RTKC Standard 16.17, paragraph 16.17.2.1 must be complied with. If any cables are identified, and any cables are within 5 feet of the proposed excavation, a close proximity permit will be required.

15.1.3.11 Employees and contractors exposed to electrical hazards shall receive electrical hazard training at the commencement of their employment and thereafter on an annual basis. The training shall address the equipment and conditions specific to the work area of the personnel and be documented.

15.1.3.12 The following policies and procedures apply to all electrical / motor control rooms containing switches, motor starters, breakers, fuses

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and their accessories, located near the point of entrance of supply conductors to a "building or other structure" or an otherwise defined as a "*controlled area*", and intended to constitute the main point of control.

- For purposes of this provision, a switch room / MCC room is defined as a room dedicated to electrical distribution and control equipment. If switchgear / MCC is located in a room or facility in which routine non-electrical operational and / or maintenance activities may take place, these are not considered controlled areas provided that:
 - The maximum voltage is less than 1,000 volts, the incident energy of any panel is no higher than Category 2, and the total amperage does not exceed 1,200 amperes.
 - Energized parts are inaccessible.
 - A system is in place to maintain arc flash and shock approach boundaries during maintenance activities.
 - The MCCs are protected from mobile equipment and other activities that may take place in the area.
 - Working space around the equipment must be maintained to provide safe access / egress at all times.
 - A risk assessment is in place that confirms that the MCC and potential activities are compatible without risk to personnel or equipment.
 - A list of such areas is maintained and approved by the site manager
- Electrical panels, enclosures, control centers, substations and equipment shall be appropriately guarded, labeled, and made inaccessible (except for emergency shut off mechanisms) to unauthorized personnel. Areas containing

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such equipment are “controlled areas”.

- Access to “controlled areas” shall be restricted to competent or authorized personnel only. Access, will be controlled by locked doors or other appropriate means. Where it is necessary for untrained personnel (e.g. visitors) to enter controlled areas there shall be a system for communicating the hazards and for escorting them with appropriately trained personnel. Contractors must have a permit to work in controlled areas.
- Keys for entry into controlled areas shall be issued by the electrical superintendent or a delegate, and a register shall be kept all keys that have been issued.
- Suitable "Danger" signs shall be posted at the entrance to all major electrical installations. Metal-enclosed switchgear, unit substations, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate "Caution" signs. Principal power switches shall be labeled to show which units they control. The labeling shall be legible, durable and distinctive.
- Signs indicting the maximum voltage present shall be posted at the entrance to all electrical installations. The labeling shall be legible, durable and distinctive.
- Signs indicating the control room that needs to be contacted, and the method of communication, before entering controlled areas that house switchgear that can be remotely opened or closed will be posted at the entrances to the controlled area.
- Controlled areas that house switchgear that can be remotely opened or closed will require entrants to inform that applicable control room of their intention to enter, and the reason for entering. The applicable control room will be informed once the entrants have left the controlled area
- All electrical rooms shall be kept clean and orderly. All doors, inspection and cover plates on electrical equipment

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shall be kept in place at all times except during testing, installation or repairs.

- All personnel doors will be equipped with panic hardware and swing outward to allow rapid egress in the event of an emergency.
- Electrical rooms shall not be used as shop facilities, storage areas or lunchrooms. All electrical rooms will be posted as "**NO SMOKING**" areas. Combustible materials shall not be stored in any electrical room nor shall they be stored or allowed to accumulate within 25 feet of an electrical substation. Electric room engineering documentation and diagrams are acceptable but must be properly stored in racks or storage files.
- Insulated platforms, insulating mats, or other electrically non-conductive material shall be kept in place at all switchboards and power-control switches where a shock hazard exists.
- Working space around electrical equipment shall be provided in accordance with the National Electrical Code. Where there is access to exposed energized parts, measures such as de-energization or the use of insulated gloves or blankets shall be used in accordance with safe work procedures.
- The electrical group is responsible for the upkeep, equipment integrity, maintenance and housekeeping of all electrical equipment and installations inside the electrical room.

15.1.4 **GROUNDING**

15.1.4.1 The path from circuits, equipment, structures, and conduit or enclosures to ground shall be permanent and continuous, have ample carrying capacity to safely conduct the currents liable to be imposed on it, and have impedance sufficiently low to limit the potential rise above ground and to cause the operation of

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overcurrent devices to isolate the circuit.

- Grounding grids and driven rod electrodes shall have a resistance to ground not to exceed 25 ohms. Where the resistance is above 25 ohms, two or more electrodes connected in parallel shall be used.
- The resistance of a motor frame to grounded building steel shall not exceed one (1) ohm.
- Electrical equipment shall be grounded in accordance with all applicable federal and state regulations, National Electric Code and National Electrical Safety Code requirements.

15.1.4.2 All structures, hardware, shield wires, and pole-mounted transformers shall be grounded.

15.1.4.3 All exposed metal parts of switches, structures, transformers, fences, gates, buildings, switchboards, breakers, meters, relays, lightning arresters, and communication equipment shall be grounded.

- All substations shall have a ground grid to which all equipment is bonded. Resistance of grid to earth shall not exceed 25 ohms.

15.1.4.4 **FIXED EQUIPMENT**– Equipment that is fastened in place or connected by permanent wiring methods. Exposed non-current-carrying metal parts of fixed electrical equipment including motors, generators, frames, and rails of electrically operated cranes, electrically driven machinery, etc. shall be grounded.

15.1.4.5 **PORTABLE EQUIPMENT**- Equipment that is fed with portable cords or cables intended to be moved from one place to another. The non-current-carrying metal parts of portable and / or plug-connected equipment shall be grounded.

- Portable electric-powered equipment such as conveyors, electric shovels, drills, etc. with associated portable substations, and switchgear shall be connected to a safety

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ground system. Trailing cables powering such equipment will have adequately sized ground conductors with continuously monitored ground continuity check equipment.

- Portable tools and appliances protected by UL approved system of double insulation, or its equivalent, need not be grounded. Where such an approved system is used, the equipment shall be distinctively marked. Where grounding is required, a verification of ground continuity shall be performed quarterly.
- Extension cords used with portable electric tools and appliances shall be of three-wire type and shall be maintained in good condition. A verification of ground continuity shall be performed quarterly.
- Completion of the quarterly inspection shall be recorded by distinctively marking the equipment with insulation tape at the plug end as per the following table:

Quarter	Season	Color
January to March	Winter	White
April to June	Spring	Green
July to September	Summer	Red
October to December	Fall	Orange

15.1.4.6 **PORTABLE and VEHICLE-MOUNTED GENERATORS**- unless the owner's manual dictates otherwise, the frame of a portable generator shall not be required to be connected to a grounding electrode for a system supplied by the generator under the following conditions:

- The generator supplies only equipment mounted on the generator, cord-and-plug-connected equipment through receptacles mounted on the generator, or both, and
- The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

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Vehicle-Mounted Generators - The frame of a vehicle shall not be required to be connected to a grounding electrode for a system supplied by a located on this vehicle under the following conditions:

- The frame of the generator is bonded to the vehicle frame, and
- The generator supplies only equipment located on the vehicle or cord-and-plug connected equipment through receptacles mounted on vehicle, or both equipment located on the vehicle and cord-and-plug connected equipment through receptacles mounted on the vehicle or on the generator, and
- The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

15.1.4.7 Portable Welders - must be plugged into an approved receptacle and equipped with the following:

- A disconnect switch or circuit breaker in the supply system.
- A nameplate giving electrical data for the welder.
- An approved welding lead.

15.1.4.8 All temporary wiring shall be effectively grounded in accordance with the National Electrical Code.

15.1.4.9 Operators / craftsmen shall conduct the following tests. (See attached procedure and recordkeeping forms – Exhibit 15.1.2 – 15.1.5)

- Equipment grounding conductors - continuity and resistance must be tested immediately after installation, repair, or modification, and annually if conductors are subjected to vibration, flexing, or corrosive environments.

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- Grounding electrode conductors - continuity and resistance must be tested immediately after installation, repair, or modification, and annually if conductors are subjected to vibration, flexing, or corrosive environments.
- Grounding electrodes - resistance must be tested immediately after installation, repair, modification, and annually thereafter.

15.1.4.10 Conductors in fixed installations, such as rigid conduit, armored cable, raceways, cable trays, etc. that are not subjected to vibration, flexing, or corrosive environments may be examined annually by visual observation to check for damage in lieu of the annual resistance test.

15.1.4.11 Grounding conductors in trailing cables, power cables, and cords that supply power to tools and portable or mobile equipment must be tested. This requirement does not apply to double insulated tools or circuits protected by ground-fault-circuit interrupters (GFCI).

15.1.4.12 Testing of equipment grounding conductors and grounding electrode conductors is not required if a fail-safe ground wire monitor is used to continuously monitor the grounding circuit and which would cause the circuit protective devices to operate when the grounding conductor continuity is broken.

15.1.5 PORTABLE ELECTRICAL EQUIPMENT

15.1.5.1 The exposed non-current carrying metal parts of portable and / or plug-connected tools, welders and other equipment must be grounded.

- Portable tools and appliances with an approved system of double insulation need not be grounded. To avoid the grounding requirements the item being used must be clearly marked as being double insulated.

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15.1.5.2 Hand-held power tools must be inspected before each use for damage or alteration. Unsafe conditions must be corrected before the tool is used.

- Hand-held power tools such as power drills, disc sanders, grinders, circular saws, and chain saws when used in the hand held mode shall be operated with controls which require constant hand or finger pressure.
- Hand-held power tools shall not be operated at voltages above 120 volts.
- Disconnect tools when not in use, before servicing and cleaning, and when changing accessories such as blades, bits, and cutters.
- All factory installed guarding must be in place when operating any hand tool.
- All hand held power tools must be fed off a GFCI protected circuit as per clause 15.1.3.4

15.1.5.3 Electrical cords must be protected from physical damage. Before use power cords must be inspected for missing ground prong and damaged insulation or damage to the plug or receptacle and be current with the grounding continuity verification requirement.

15.1.6 JUMPER PERMIT

15.1.6.1 Jumpers can be used on any interlock, contact, loop, etc. that has **temporarily** been put out of service. This includes hardwire and software types. Jumpers can only be installed by trained electrical or control systems employee(s) or other qualified and authorized personnel designated by plant management.

15.1.6.2 Prior to installation of the jumper, a "Jumper Permit / Jumper Tag" (see Exhibit 15.1.6 **a and b**) must be completed and approved by an authorized person as designated by plant management. The completed Jumper Permit will be forwarded to the electrical

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supervisor for inclusion in the Jumper Log. The Jumper logging, approval and tracking may use either the manual or approved electronic system.

- 15.1.6.3 The Jumper Tag must be placed on the device or inside the panel where the jumper is contained. For software jumpers (or temporary modification), the Jumper Tag must be placed in the PLC / CPU rack. When a control system technician or electrician removes a jumper, the tag must be returned to the electrical supervisor and the Jumper Permit updated that the jumper was removed.
- 15.1.6.4 A Jumper Log must be maintained by the electrical supervisor or other plant designee. The log must contain all pertinent information, including dates jumpers were installed and removed with a copy of the Jumper Permit. The record log must be kept for a minimum of two years.
- 15.1.6.5 Under no circumstances will a jumper be used to bypass an emergency safety shutdown device, e.g., pull cord switch, stop button, etc. Also, jumpers will not be used to deactivate or circumvent an activated lock out system. Whenever installing a jumper that may affect personnel safety a risk assessment must be completed.
- 15.1.6.6 Precautions must be taken on equipment when protection devices are jumpered, e.g., lube flow switches, RTDs, etc.; precautions could include more frequent interval inspections of equipment, temporary replacement devices, or constant employee watch. In any case, the risk of equipment loss must be reduced to the maximum extent possible.

15.1.7 MEDIUM AND HIGH VOLTAGE ELECTRICAL TRANSMISSION AND DISTRIBUTION LINES (Overhead Powerlines)

- 15.1.7.1 **GROUNDING-** Wood structures shall have a copper butt plate and spiral wrapped with a minimum #6 AWG soft-drawn copper wire up to ground level. Spiral wraps shall be short-circuited together by the vertical ground wire and stapled at every crossing. The wire is to be

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extended straight up the pole and stapled at no more than three foot intervals. All hardware and shield wires shall be connected to pole ground wires.

- Steel lattice-type towers shall be grounded through the steel structure. Bolted joints shall be inspected for tightness at such intervals as experience has shown to be necessary.
- Tubular steel towers shall be grounded through anchor bolts and grounding lugs provided.
- Ground resistance should be monitored at strategic locations and records kept.

15.1.7.2 All transmission lines shall have shield or static wires in place. Shield wires shall be extra high strength galvanized steel or copper-clad steel, as determined by location and shall be securely connected to structure ground conductors. Lightning arrestors shall be installed at transformer bank primaries, fused disconnects, and in substations.

15.1.7.3 Warning signs must be posted on all steel transmission line towers. Signs shall be mounted at a height of 5 to 7 feet on all four sides of the tower. These signs shall clearly indicate **Danger and High Voltage**.

15.1.7.4 Climbing steps will be installed on steel structures, if needed, and will begin at a point at least 12 feet above ground level. Steps below 12 feet high will be removed. Steps will not be installed on wood poles. Structures accessible by the public will have steps beginning at 15 feet above ground level, if steps are required.

15.1.7.5 Vertical and horizontal clearances between power lines and ground or other obstructions will be in accordance with published standards, taking into account line voltage, structure type, loading class, span length, type of terrain, and all other applicable constraints.

- Approved clearances will be maintained between energized conductors and grounded structure parts. Energized conductors with less than minimum clearance will be shielded

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or insulated to protect personnel and equipment. Safety hazard signs shall also be posted.

- Any powerline that could be an obstruction to air navigation will be identified by marker balls. This includes overhead lines exceeding 200 feet above ground level. In the event of a valley, ravine or gorge, the lowest point is used to determine elevation.
 - Markers should be spaced equally along the wire at intervals of approximately 200 feet or fraction thereof.

15.1.7.6 Insulation of energized conductors from structures shall be installed in accordance with operating voltage, impulse level required, and ambient conditions.

15.1.7.7 All transmission lines shall be visually inspected at such intervals as experience has shown to be necessary. Inspections shall be documented and corrective action shall be promptly taken to correct problems identified during the inspection.

- Switches shall be exercised at such intervals as experience has shown to be necessary.

15.1.7.8 An infrared thermographic survey of all transmission lines shall be conducted at such intervals as experience has shown to be necessary. Any hot spots discovered in the thermographic survey shall be promptly corrected. Accurate records of location, equipment, and temperature rise shall be taken and maintained.

15.1.7.9 Areas around wood poles subject to weed growth shall have an environmentally-acceptable herbicide applied in a six-foot radius around each pole at intervals as necessary to control weeds and eliminate danger of pole damage from ground fires.

15.1.7.10 Guy wires on wood poles shall have insulators installed at 8 feet above ground level to protect personnel. Guy wires shall be adequately marked and protected from damage.

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15.1.7.11 Line work shall be performed only by qualified linemen.

- Tools and safety equipment shall be inspected and tested at prescribed intervals.
- Wherever possible, before line work is begun, the line will be isolated and grounded according to the KUC Lock and Tag Standard 16.12, Kennecott Electrical Switching Procedures, and the Kennecott Substation and Switchyards Manual.
- Hot line work, if required, will be performed in strict compliance with established procedures.

15.1.7.12 New construction and maintenance shall conform to all applicable requirements contained in this standard and all other codes and regulations.

15.1.7.13 Wherever overhead powerlines cross any road where vehicles may inadvertently contact the overhead powerline, the crossings shall have signage on all approaches to the overhead line crossing.

Where possible, the signage will be placed at least 100 feet from the overhead line. In active mining areas where road layouts are frequently changed, large format signs can be placed on the overhead line structures directly adjacent to the crossing.

The sign will contain the following information:

- Voltage of the overhead line
- Maximum height of any vehicle that can pass through without a permit (Distance between highest portion of road and lowest conductor less 20 feet). See exhibit 15.1.8 Vehicles in transit cannot be within 10 feet of energized OHL greater than 50kV, or within 4 feet of energized OHL less than or equal to 50kV, without the written authorization of the site electrical lead, and if required, a close proximity permit.
- All overhead line crossings will be marked on a topographical map of the area, and will be maintained by the plant electrical superintendent or delegate

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- The overhead line crossings will be inspected at a minimum frequency of every two years, and the topographical map updated if required. This inspection shall check the accuracy and legibility of the signage.

15.1.8 ILLUMINATION

15.1.8.1 Adequate illumination shall be provided for all working spaces around electrical equipment. Whenever possible, natural lighting should be utilized in all working areas. Artificial lighting must be adequate for the type of work being performed in an area, especially where hazardous or night work situations are involved. Energy efficient lighting products must be considered whenever changing existing lighting or designing new lighting layouts. Illumination levels should be maintained to the latest ANSI Lighting Standards.

15.1.9 INSULATED TOOLS

15.1.9.1 Insulated tools shall be used whenever work is taking place near exposed energized components at or above 50V (AC or DC). No work is allowed near exposed energized components at or above 1000V.

15.1.9.2 Insulated tools shall be rated to insulate against the highest voltage present

15.1.9.3 Insulated tools shall be inspected before each use

15.1.9.4 If the tools have two color insulation they must be taken out of service if the second color is visible.

15.1.9.5 For single color insulation the tool must be taken out of service as it becomes damaged. Wrapping in insulating tape is not an acceptable repair of a non-conductive tool

15.1.9.6 Personnel required to use insulated tools shall be trained on proper inspection and limitations of non-conductive tools.

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KUC ELECTRICAL STANDARD			
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15.1.9.7 Insulated tools shall be available for all work that is possible to have an exposed energized component nearby. Non-conductive tools for common work such as a screw driver shall be provided and kept in the inventory of electricians

15.1.9.8 Insulated tools must be kept clean and dry during use

15.1.10 **ELECTRICAL PPE**

15.1.10.5 Arc rated (as per Arc Flash label) must be worn by all persons conducting electrical work. All persons required to wear PPE will be trained in the use and care of the PPE

15.1.10.6 Care and handling of PPE

15.1.10.6.1 Electrical PPE that protects against shock and arc flash.

15.1.10.6.1.1 Shall be stored in a manner to prevent damage from physically damaging conditions and from moisture, dust, or other deteriorating agents

15.1.10.6.1.2 Prior to each use the PPE shall be inspected for any damage.

15.1.10.6.1.3 Rubber gloves must be checked by inflation

15.1.10.6.1.4 Rubber gloves must be tested by an approved authority at intervals of every 6 months, and the gloves will be stamped with the date of inspection.

15.1.10.6.1.5 Any failed rubber glove must be made to be inoperable and taken out of service

15.1.10.6.1.6 For arc flash protection a properly arc rated thermal value cloth needs to be worn as an outer layer and

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non-melting clothing needs to be directly against the skin.

- 15.1.10.7 Care must be taken to ensure that the appropriate gloves are worn for the task. Special attention must be paid to gloves rated for arc protection versus gloves rated for shock protection.

15.1.11 Electrical Protection devices

- 15.1.11.1 All electrical circuits will be protected according the latest applicable code
- 15.1.11.2 Electrical protection devices shall be selected, installed, set and tested by person deemed qualified to do so
- 15.1.11.3 All approved relay setting shall be documented
- 15.1.11.4 Coordination studies shall be reviewed every 5 years, or whenever major changes to the electrical system have occurred.
- 15.1.11.5 All relays will be tested and calibrated every two years, and the results of these test recorded
- 15.1.11.6 All 4160V and above circuit breakers will be tested every three years, and the results of these tests recorded.

15.1.12 DESIGN FOR NEW EQUIPMENT

- 15.1.12.1 Whenever new equipment is being specified for installation, the end user should strive to procure the equipment to ensure the best available technology, ensuring the best reasonable level of safety for the operators and maintainers
- 15.1.12.2 The Engineering of the new design should consider reasonable, foreseeable future loads

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15.1.12.3 The design of the equipment must consider standardization across Kennecott.

15.1.13 HAND HELD TEST INSTRUMENTS (Multi Meters)

15.1.13.1 Hand held test instruments will never be used on voltages exceeding 1000 V

15.1.13.2 All hand held test instruments rated at least a category III

15.1.13.3 Category IV will be used when testing is required upstream from a distribution circuit. This includes testing on the primary supply source, which includes 120V or 240V overhead or underground lines that power detached buildings or underground lines that power well pumps. This covers the highest and most dangerous level of transient overvoltage electricians encounter when working on utility service equipment like exterior transformers.

15.1.13.4 Only UL rated hand held test instruments will be used (UL 61010B-1, UL 3111-2-031 and UL 3111-2-032)

15.1.13.5 Only appropriately trained persons are to use hand held test instruments.

15.1.13.6 The test instrument must be appropriately selected for the task.

15.1.13.7 The hand held test instrument must be stored, maintained and used as per the manufacturer's recommendations.

15.1.13.8 When using a hand held test instrument for verifying for the absence of voltage, the instrument shall be tested on a known source before and after the verification of absence of voltage.

15.1.13.9 The appropriate PPE shall be selected and used when using hand held test instruments.

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15.1.13.10 All the requirements of section 15.1.9 shall apply to hand held test instruments.

15.1.13 **RECORDKEEPING**

15.1.13.1 A record of the most recent continuity and resistance test or visual examination conducted must be kept and made available for internal and regulatory inspections. The records shall:

- o Identify the equipment and location tested
- o Identify the person conducting the tests
- o Identify the date of the test
- o Record meter reading to the nearest 0.1 ohm
- o Identify action taken to address readings over one (1) ohm
- o Record a re-test reading upon completion of repairs

15.1.9.2 Recordkeeping forms are provided as attachments to this standard. All records shall be maintained as designated in the KUC Records Retention Schedule.

REFERENCES:

American National Standard Practice for Industrial Lighting ANSI RP7

FAA Part 77 Airspace Obstruction Analysis

FAA Obstruction Marking and Lighting

KUC Safety and Health Standards 16.4 Cranes and Hoists

KUC Safety and Health Standard 16.12 – Lockout / Tagout (Isolation)

KUC Records Retention Schedule <http://kucsites/kucim/>

MSHA 30 CFR Part 56 & 57.12028 and Subpart K

National Electrical Code – NFPA 70

National Electrical Safety Code

OSHA 29 CFR Subpart S.

Rio Tinto Safety Standard C2 – Electrical Safety

Rio Tinto Electrical Standards Guideline Document

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KUC ELECTRICAL STANDARD			
Effective Date: 11/9/2016	Standard: 15.1	Document Number: KUCSH0065	Rev: 0

REVISION HISTORY:

MOC#	Description of Change	Prepared By	Date
12584	Scheduled review and update including adding a procedure for continuity and resistance testing recommended by the C2 Standards Committee. Also, updated format and Document number added.	KUC Safety and Health Standards Committee	6/10
18922	Scheduled review and update. Also changes incorporate requirements from combining the existing KUC H&S Standards 15.2 Lighting, 16.9 Portable Electric Equipment, 16.10 Electrical Grounding, 16.13 Jumper Permit and 16.22 Electrical Transmission Lines (which will be eliminated) into 15.1.	C2 Electrical Safety Champion KUC Safety and Health Standards Committee	03/12
34244	Significant updates to align with C2 – 2016, CRM and NFPA 70E - 2016	David Van Hees	1/24/17

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Exhibit 15.1.1

Log of Engineering Revisions					Plant: _____ Discipline: _____	Page 1 of _____
Item No.	Drawing/ PLC ID # (a)	Rev. No.	Date	Description	APPROVALS	
					(b)	(c)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10				Procedure for updating Programmable Logic Controller (PLC) software: Diskette label must show Rev. number(s), same Rev. # as shown in this log.	(a) Shaded areas reserved for related PLC revision (b) Supervisor / Plant Engineer (c) Plant Engineer's supervisor (next level in organization)	

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Exhibit 15.1.2

Procedure for Testing Continuity and Resistance of Grounding Systems

Continuity and resistance of grounding systems shall be tested immediately after installation, repair, or modification; and annually thereafter. A record of the resistance measured during the most recent test shall be made available for inspection and records shall be kept on file in accordance with the KUC records retention policy.

Fixed Plant Equipment

Annual Inspection

(A) Equipment Needed

- a. Digital or analog volt-ohmmeter
- b. Spool of copper wire of appropriate length with alligator clamps or equivalent suitable connectors at each end

(B) Zero Meter Through Wire Roll

- a. Attach one end of wire to meter
- b. Attach opposite end of wire to other meter probe
- c. Measure resistance of wire
- d. Adjust meter reading to "0" or record reading to deduct from overall resistance readings

(C) Visually Inspect Grounding System and Repair as Needed

- a. Check for obvious signs of corrosion
- b. Check for broken conduit or flex
- c. If external grounds are present, inspect for damage

(D) Record Meter Reading at Motor

- a. Attach one end of wire roll to grounded building steel ensuring good contact
- b. String out sufficient wire to reach motor and attach to meter probe
- c. Place other meter probe on motor housing ensuring good contact
- d. Record meter reading to the nearest 0.1 ohm (deduct wire roll resistance if meter not "zeroed")
- e. If resistance is higher than one (1) ohm, identify and correct deficiency

(E) Clamp on Ground meter

- a. A ground resistance tester may be used in lieu of the above method to measure the resistance of the grounding system

Repair or Modification

(A) Measure the Resistance of the equipment grounding conductor when disconnected

- a. Use method A-D above but connect one probe of meter directly to the grounding conductor instead of the motor case
- b. After the motor is connected and before energizing measure resistance of grounding system using A – E above (Annual Inspection)

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(B) Whenever grounding connections are visible or exposed during routine maintenance or troubleshooting, the grounding connections must be visually inspected.

Portable Equipment - If not connected to a ground monitoring system

(A) Equipment Needed

- a. Digital or analog volt-ohmmeter
- b. Spool of copper wire of appropriate length with alligator clamps or equivalent connector at each end

(B) Zero Meter Through Wire Roll

- a. Attach one end of wire to meter
- b. Attach opposite end of wire to other meter probe
- c. Adjust meter reading to "0" or record reading to deduct from overall resistance readings

(C) Visually Inspect Grounding System

- a. Check for obvious signs of corrosion
- b. Inspect feeder cable and connections for damage

(D) Record Meter Reading at Motor

- a. Attach one end of wire to the MCC ground feeding the power cable, ensuring good contact
- b. String out sufficient wire to reach motor and attach to meter probe
- c. Place other meter probe on motor housing ensuring good contact
- d. Record meter reading to the nearest 0.1 ohm (deduct wire roll resistance if meter not "zeroed")
- e. If resistance is higher than one ohm, identify and correct deficiency

Grounding Electrode Conductor

The continuity and resistance of the equipment grounding conductors shall be measured by an inductive device or resistance reading between the frame of the motor and grounded building steel with a resistance of less than one (1) ohm

Grounding Electrode

The resistance of the grounding electrode or grounding electrode conductor to the earth shall be measured either by reference to an established earth-grounded electrode or inductive device (clamp on ground meter) with a resistance of less than 25 ohms

Building Steel to Grounding Electrode Conductor

The conductors between the building steel and the ground grid shall be visually inspected and the resistance determined by either an inductive device or a resistance meter between the building steel and the grounding electrode. Exposed steel to grid conductors should be visually examined for the condition of bonds and wiring, and of these, a representative number should be measured.

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Inspection or Repair

When electrical equipment such as switchboards, panelboards, control panels, meter socket enclosures and motor control centers cabinet are accessed for inspection or repair, a visual inspection of the equipment grounding conductors shall be conducted.

Exhibit 15.1.3

(Designate Plant for Identification)
**CONTINUITY AND RESISTANCE GROUND SYSTEM LOG
 MODIFICATIONS AND / OR REPAIRS**

DATE _____ ELECTRICIAN (S): _____ SUPERVISOR: _____

MODIFICATIONS	LOCATION:
	REASON:
	DESCRIPTION:
	TEST READINGS:
REPAIRS	LOCATION:
	REASON:
	DESCRIPTION:
	TEST READINGS:
NEW INSTALLATION	LOCATION:
	REASON:
	DESCRIPTION:
	TEST READINGS:
COMMENTS:	

Distribution:
 Maintenance Superintendent
 Plant Records

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Exhibit 15.1.4

EQUIPMENT GROUNDING CONTINUITY AND RESISTANCE ANNUAL TESTING PROGRAM PLANT:

EQUIPMENT NUMBER	LOCATION/DESCRIPTION	MOTOR FRAME TO BUILDING STEEL (OHMS TO 1 DECIMAL)	PERSON PERFORMING TESTS	DATE	COMMENTS

Distribution:
Maintenance Superintendent
Plant Records

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Exhibit 15.1.6

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JUMPER PERMIT (Standard 15.1)

Rev 6 – 02/12

TAG NO.

EMOC #

EQUIPMENT NUMBER DATE

DEVICE JUMPERED TIME AM PM

Work Order No. Hardwire? Yes No Software? Yes No

Duration of Permit From To

Reason for Jumper:

Recommendations concerning safety, operating restrictions, or special instructions:

APPLICABLE INFORMATION:

Location & Equipment Description <input type="text"/>							
DWG <input type="text"/>	MCC <input type="text"/>	Term. Box <input type="text"/>	Wire No. <input type="text"/>				
PLC External Force: Cabinet <input type="text"/>		Block <input type="text"/>	I/O Point <input type="text"/>				
PLC Software: PLC ID No. <input type="text"/>		Rung <input type="text"/>	I/O Point <input type="text"/>				

	Print Name	Signature	Date
Requested By	<input type="text"/>	<input type="text"/>	<input type="text"/>
Approved By	<input type="text"/>	<input type="text"/>	<input type="text"/>
Installed By	<input type="text"/>	<input type="text"/>	<input type="text"/>

JUMPER REMOVAL

Print Name	Signature	Date

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Removed By			
Distribution	Electrical Supervisor		

○

TAG NO.

JUMPER TAG

TRACK completed for this task (*Initials*):

APPROVED BY

EQUIPMENT NO.

INSTALLED BY

DATE

TIME

	PM
	AM

NOTE:

RECORD ALL INFORMATION IN "JUMPER LOG" BOOK.

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Exhibit 15.1.7 Arc Flash Labels

⚠ **WARNING**

Arc Flash and Shock Hazard
Appropriate PPE Required

ARC FLASH PROTECTION

1	Flash Hazard Category
97 in	Flash Hazard Boundary
3.1 cal/cm²	Flash Hazard at 36 in
13800 VAC	Voltage Shock Hazard

PERSONAL PROTECTIVE EQUIPMENT

Arc-Rated Clothing, Minimum Rating 4 cal/cm²
AR shirt & pants or coverall
AR face shield or AR flash suit hood

Protective Equipment
Hearing protection
Heavy duty leather gloves **Glove Class: 2**

PROTECTIVE DEVICE SETTINGS

Prot Dev Name: 52F-2B12-50/51	INST: 3.0 (1260A)
LTPU: 0.7 (420A)	STPU:
LTD: 24	STD:

Location: **500-XF-001 PRI**
Date Issued: **06/26/2014** Study By Sunrise Engineering

Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements

⚠ **WARNING**

Arc Flash and Shock Hazard
Appropriate PPE Required

ARC FLASH PROTECTION

2	Flash Hazard Category
41 in	Flash Hazard Boundary
4.5 cal/cm²	Flash Hazard at 18 in
480 VAC	Voltage Shock Hazard

PERSONAL PROTECTIVE EQUIPMENT

Arc-Rated Clothing, Minimum Rating 8 cal/cm²
AR shirt & pants or coverall
AR flash suit hood or AR face shield + balaclava

Protective Equipment
Hearing protection
Heavy duty leather gloves **Glove Class: 00**

PROTECTIVE DEVICE SETTINGS

Prot Dev Name: 52-405	INST: 15 (12000A)
LTPU: 1 (800A)	STPU: 7 (5600A)
LTD: 4	STD: Min (1/2t Off)

Location: **5120-MC-504**
Date Issued: **06/26/2014** Study By Sunrise Engineering

Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements

⚠ **WARNING**

Arc Flash and Shock Hazard
Appropriate PPE Required

ARC FLASH PROTECTION

3	Flash Hazard Category
59 in	Flash Hazard Boundary
8.4 cal/cm²	Flash Hazard at 18 in
480 VAC	Voltage Shock Hazard

PERSONAL PROTECTIVE EQUIPMENT

Arc-Rated Clothing, System Min Rating 25 cal/cm²
AR shirt & pants + coverall
AR flash suit hood
AR flash suit jacket + pants
AR gloves

Protective Equipment
Hearing protection
Glove Class: 00

PROTECTIVE DEVICE SETTINGS

Prot Dev Name: 52-403	INST: 15 (12000A)
LTPU: 1 (800A)	STPU: 7 (5600A)
LTD: 4	STD: Min (1/2t Off)

Location: **5120-MC-501**
Date Issued: **06/26/2014** Study By Sunrise Engineering

Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements

⚠ **WARNING**

Arc Flash and Shock Hazard
Appropriate PPE Required

ARC FLASH PROTECTION

4	Flash Hazard Category
937 in	Flash Hazard Boundary
28 cal/cm²	Flash Hazard at 36 in
4160 VAC	Voltage Shock Hazard

PERSONAL PROTECTIVE EQUIPMENT

Arc-Rated Clothing, System Min Rating 40 cal/cm²
AR shirt & pants + coverall
AR flash suit hood
AR flash suit jacket + pants
AR gloves

Protective Equipment
Hearing protection
Glove Class: 1

PROTECTIVE DEVICE SETTINGS

Prot Dev Name: S5-128-50/51	INST:
LTPU: 6.0 (2400A)	STPU:
LTD: 6.0	STD:

Location: **5122-02B PRI**
Date Issued: **06/26/2014** Study By Sunrise Engineering

Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements

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⚠ WARNING

**Arc Flash and Shock Hazard
Appropriate PPE Required**

ARC FLASH PROTECTION

0	Flash Hazard Category
10 in	Flash Hazard Boundary
0.44 cal/cm ²	Flash Hazard at 36 in
4160 VAC	Voltage Shock Hazard

PERSONAL PROTECTIVE EQUIPMENT

Protective Clothing, Untreated Natural Fiber
Long sleeve shirt & pants

Protective Equipment

Hearing protection
Heavy duty leather gloves Glove Class: 1

PROTECTIVE DEVICE SETTINGS

Prot Dev Name: 52M-3E-51	INST: 2.0 (480A)
LTPU: 1.0 (240A)	STPU:
LTD: 9.0	STD:

Location: **546-MC-501A**
Date Issued: **06/26/2014** Study By Sunrise Engineering

Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements

⚠ DANGER

**NO SAFE PPE EXISTS
ENERGIZED WORK PROHIBITED**

ARC FLASH PROTECTION

D	Flash Hazard Category
1578 in	Flash Hazard Boundary
47 cal/cm ²	Flash Hazard at 36 in
2400 VAC	Voltage Shock Hazard

DANGEROUS! DO NOT WORK ON LIVE!

Protective Equipment

DO NOT WORK ON LIVE! Glove Class: 1

PROTECTIVE DEVICE SETTINGS

Prot Dev Name: FU-XF-S1	INST:
LTPU:	STPU:
LTD:	STD:

Location: **2.4kV PARK "A"**
Date Issued: **06/26/2014** Study By Sunrise Engineering

Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements

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Exhibit 15.1.8 Examples of Overhead Line Crossing warnings signs

